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NORTH CAROLINA AIR QUALITY MAINTENANCE AREA ANALYSIS

VOLUME I. TSP AREA SOURCE EMISSION INVENTORIES FOR CHARLOTTE, WINSTON-SALEM, AND GREENSBORO AQMA'S FOR 1973, 1975, 1980, AND 1985

ENGINEERING-SCIENCE, INCORPORATED

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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NORTH CAROLINA AIR QUALITY MAINTENANCE AREA ANALYSIS

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FINAL REPORT

VOLUME I

TSP AREA SOURCE EMISSION INVENTORIES
FOR CHARLOTTE, WINSTON-SALEM, AND GREENSBORO
AQMA'S FOR 1973, 1975, 1980, AND 1985

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV

AIR AND HAZARDOUS MATERIALS DIVISION
ATLANTA, GEOGIA 30309

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Raleigh, North Carolina

By

Engineering-Science, Inc.
7903 Westpark Drive
McLean, Virginia 22101

This air pollution report is issued by Region IV, Environmental Protection Agency, to assist state and local air pollution control agencies in carrying out their program activities. Copies of this report may be obtained, for a nominal cost, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22151.

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CHAPTER I

INTRODUCTION

Engineering-Science, Inc. is under contract to the Environmental Protection Agency, Region IV, to assist the North Carolina Department of Natural and Economic Resources, Office of Water and Air Resources in the analysis phase of the air quality maintenance program. Three air quality maintenance areas are involved: Mecklenburg County AQMA, Forsyth County AQMA, and Guilford County AQMA, all for suspended particulate matter only.

In general, ES is responsible for the analysis of area sources and the State for point sources. The ES work program was divided into four activity areas:

1. Update of the 1973 baseline year emission inventory.
2. Allocation of the baseline year emission inventory to subcounty and/or AQDM grid squares.
3. Projection of county or subcounty emission inventories to 1975, 1980, and 1985.
4. Allocation of the projected emission inventories to subcounty and/or AQDM grid squares.

This final report summarizes the work done which has resulted in the completion of the load sheets for AQDM 1973 calibration, the 1973 NEDS update and load sheets for 1975, 1980, and 1985 projection years. These have been forwarded to the North Carolina Department of Natural and Economic Resources.

Throughout the project, wherever possible and to the degree possible, we have carefully followed the instructions contained in EPA documents and publications. In particular, we have relied on the methodologies contained in the following:

- Compilation of Air Pollution Emission Factors - AP-42.
- Guide for Compiling a Comprehensive Emission Inventory - APTD-1135.
- Guidelines for Air Quality Maintenance Planning and Analysis. Volume 7: Projecting County Emissions.

- Guidelines for Air Quality Maintenance Planning and Analysis. Volume 13: Allocating Projected Emissions to Subcounty Areas.
- 40 CFR 51. Maintenance of National Ambient Air Quality Standards.

Completion of the project within the funding and time constraints imposed would have been impossible without the assistance and cooperation of the Department of Natural and Economic Resources, the Research Triangle Institute who were responsible for dispersion model application in the project, and the Environmental Protection Agency, Region IV, Project Office. In particular we wish to acknowledge the help and advice provided by Mr. Gary Kilkelly and Mr. Brock Nicholson of the Department, Mr. Richard Haws of RTI and Mr. Randy Mayfield of EPA.

CHAPTER II

FUEL SURVEY

Annual fuel sales for gas, oil, and coal are reported by states in the U.S. Department of the Interior, Bureau of Mines, Mineral Industry Surveys (MIS) series. After first removing fuel sales from the state total which do not apply to the study areas (fuel for vessel bunkering for instance), the remaining fuel sales can be converted to Btu's and allocated to the county by population.

This procedure was followed for Mecklenberg, Forsyth, and Guilford Counties in North Carolina to obtain the base year total Btu consumption for each county. This step is required because, although it is reasonable for average per capita Btu consumption to change slowly with latitude (barring the effects of large water bodies, mountains, etc.), the types of fuels burned can change radically between even adjacent counties. Direct population-based allocation of MIS total state fuels by fuel type will lead to fuel type allocation errors which can approach 40%. Table 1 illustrates the potential for error in allocation by fuel type.

The 13% difference in the three-county total shown in Table 1 can probably be accredited to a high per capita consumption of natural gas in these counties rather than to errors originating in the assumption of a state-wide average per capita Btu consumption. Natural gas was chosen for this illustration because of the very accurate and complete response which is generally made by the natural gas dealers (or dealer) when a fuel survey is taken.

The direct fuel survey totals indicated in Table 1 were obtained by summing the fuel sales reported on direct mail questionnaires sent to all fuel companies listed in local phone books. (Fourteen phone books were used for the North Carolina survey.) Several hundred questionnaires were sent out in the first mailing and a second mailing was made to those dealers who did not respond to the first survey. The survey was conducted at the "jobber" or final sales level so that an accurate fuel use distribution could be made for residential, commercial/institutional, and industrial class fuel users.

TABLE 1

COMPARISON OF DIRECT FUEL ALLOCATION BY

POPULATION WITH ACTUAL BTU DETERMINED BY FUEL SURVEY

	Allocation Factor	Allocation (Btu) Natural Gas	Other Fuels
1973 NC fuel usage from MIS (Highway, utility and similar fuels are removed.)	1.000	1.66×10^{14}	2.46×10^{14}
Mecklenburg County			
Allocated from State Total:	0.072	1.19×10^{13}	1.76×10^{13}
Determined by Survey:		1.27×10^{13}	
% Accounted for:		106.7%	
Forsyth County			
Allocated from State Total:	0.042	6.96×10^{12}	1.03×10^{13}
Determined by Survey:		6.11×10^{12}	
% Accounted for:		87.8%	
Guilford County			
Allocated from State Total:	0.057	9.47×10^{12}	1.41×10^{13}
Determined by Survey:		1.32×10^{13}	
% Accounted for:		139.4%	
Three-County Total			
Allocated from State Total:	0.171	2.83×10^{13}	4.2×10^{13}
Determined by Survey:		3.20×10^{13}	
% Accounted for:		113.1%	

Sample calculation for Forsyth County:

Allocation factor:

$$\frac{\text{County Population}}{\text{State Population}} = \frac{222,276}{5,302,000} = 0.042$$

Allocation from State total:

$$0.042 \times 1.66 \times 10^{14} = 6.96 \times 10^{12}$$

% accounted for:

$$\frac{6.11 \times 10^{12}}{6.96 \times 10^{12}} = 87.3\%$$

It is important to note here that some of the fuel in this survey was sold to point sources and was subtracted from the total so that the remaining fuels used by area sources could be allocated. Because the local fuel dealers would be unable to distinguish between area source and point source customers, ES requested that the point source interviewing process conducted by the State include questions pertaining to fuel purchases.

The point source interview program included point source fuel acquisition by fuel type and fuel dealer. After removal of fuels reported commonly by the two separate North Carolina surveys, the survey totals were converted to Btu's for comparison to the population allocated MIS Btu's. Table 2 compares the total county Btu consumption as obtained by these two methods. The combined fuel surveys accounted for from 76% to 100% of the Btu's expected from per capita Btu allocation of state fuels. The final fuel usage for Mecklenburg, Forsyth, and Guilford Counties was determined by increasing the oil and gas survey fuel totals by fuel type to the MIS total on a Btu basis while keeping natural gas usage constant.

The natural gas sales reported by local gas companies can be taken as highly accurate and a general adjustment of Btu's supplied by natural gas would be inappropriate here.

Total area source fuel usages for Mecklenburg, Forsyth, and Guilford Counties by type of customer and type of fuel are shown in Tables 3 through 5. The totals in Tables 3 through 5 have been adjusted to the MIS totals where necessary except for residential wood usage which is calcualted from 1970 census data using the procedure outlined in Reference (1): 0.0017 tons/dwelling unit-degree day.

TABLE 2

ALLOCATED MIS BTU'S VS. "JOBBER" - USER FUEL SURVEY

County	MIS Total Btu's	Combined Point and Area Source Survey Btu's
Mecklenburg	2.94×10^{13}	2.23×10^{13}
Forsyth	1.73×10^{13}	1.74×10^{13}
Guilford	2.35×10^{13}	2.22×10^{13}

TABLE 3

AREA SOURCE FUEL TOTALS FOR

MECKLENBURG COUNTY

Type of Fuel Sold	Units	Type of Customer			
		Residential	Commercial/ Institutional	Industrial	Other[1] (Specify)
Bituminous Coal	tons	3,717	10,680	356	
Residual Oil	gals		3,787,758		
Distillate Oil	gals	25,956,115	16,738,425	36,516,817	1,647,013
Natural Gas	ft^3	$5,413 \times 10^6$	$2,903.1 \times 10^6$	928.9×10^6	39×10^6
Liquefied Petroleum Gas (LPG)	gals	3,234,681	7,757,817	8,241,824	22,698
Wood	tons	2,449			

(1) Construction and agricultural use area sources accounted for in other source categories.

TABLE 4

AREA SOURCE FUEL TOTALS FOR
FORSYTH COUNTY

Type of Fuel Sold	Units	Type of Customer			
		Residential	Commercial/ Institutional	Industrial	Other (1) (Specify)
Bituminous Coal	tons	2,600	300		
Residual Oil	gals		700,000		
Distillate Oil	gals	23,429,231	3,031,702	6,528,039	107,100
Natural Gas	ft^3	$1,659.3 \times 10^6$	757.4×10^6	$1,247.6 \times 10^6$	
Liquefied Petroleum Gas (LPG)	gals	3,860,749	928,276	1,620,659	211,176
Wood	tons	3,893			

(1) Construction and agricultural use area sources accounted for in other source categories.

TABLE 5

AREA SOURCE FUEL TOTALS FOR

GUILFORD COUNTY

Type of Fuel Sold	Units	Type of Customer			
		Residential	Commercial/ Institutional	Industrial	Other (Specify)(1)
Bituminous Coal	tons	6,408	423	227.9	
Residual Oil	gals		1,193,500	651,646	
Distillate Oil	gals	39,252,045	420,444	5,664,219	542,500
Natural Gas	ft^3	$5,124.5 \times 10^6$	$2,943.6 \times 10^6$	$1,131.7 \times 10^6$	23.9×10^6
Liquefied Petroleum Gas (LPG)	gals	4,006,543	479,923	1,422,984	271,250
Wood	tons	7,484			

(1) Construction and agricultural use area sources accounted for in other source categories.

CHAPTER III

AREA SOURCE EMISSION INVENTORY

The following paragraphs discuss the data requirements, data sources and availability, emission factors, and the methodology for determining county-wide emission totals for the 15 area source categories which were assigned to Engineering-Science.

1. RESIDENTIAL FUEL USAGE

Using the fuel totals from Tables 3 through 5, county-wide emissions from residential fuel usage were calculated as follows:

	Fuel Used	Emission Factor[1]	Emissions (tons/yr)
Mecklenburg			
Bituminous Coal (tons)	3,717	17 lbs/ton[2]	31.6
Distillate Oil (10^3 gal)	25,956	10 lbs/10^3 gal	129.8
Natural Gas ($10^6 ft^3$)	5,413	10 lbs/$10^6 ft^3$	27.1
LPG (10^3 gal)	3,235	1.85 lbs/10^3gal[3]	3.0
Wood (tons)	2,449	25 lbs/ton	30.6
TOTAL			222.1
Forsyth			
Bituminous Coal (tons)	2,600	17 lbs/ton[2]	22.1
Distillate Oil (10^3 gal)	23,429	10 lbs/10^3 gal	117.2
Natural Gas ($10^6 ft^3$)	1,659	10 lbs/$10^6 ft^3$	8.3
LPG (10^3 gal)	3,861	1.85 lbs/10^3 gal[3]	3.6
Wood (tons)	3,893	25 lbs/ton	48.7
TOTAL			199.9
Guilford			
Bituminous Coal (tons)	6,408	17 lbs/ton[2]	54.5
Distillate Oil (10^3 gal)	39,252	10 lbs/10^3 gal	196.3
Natural Gas ($10^6 ft^3$)	5,125	10 lbs/$10^6 ft^3$	25.6
LPG (10^3 gal)	4,007	1.85 lbs/10^3 gal[3]	3.7
Wood (tons)	7,484	25 lbs/ton	93.6
TOTAL			373.7

(1) Source: Reference 2.
(2) 50% spreader stoker furnaces burning 7% ash coal and 50% hand-fired units.
(3) 50% propane, 50% butane.

2. COMMERCIAL/INSTITUTIONAL FUEL USAGE

Using the fuel totals from Tables 3 through 5, county-wide emissions from commercial/institutional fuel usage were calculated as follows:

	Fuel Used	Emission Factor[1]	Emissions (tons/yr)
Mecklenburg			
Bituminous Coal (tons)	10,680	14 lbs/ton[2]	74.8
Residual Oil (10^3 gal)	3,788	23 lbs/10^3 gal	43.6
Distillate Oil (10^3 gal)	16,738	15 lbs/10^3 gal	125.6
Natural Gas ($10^6 ft^3$)	2,903	10 lbs/$10^6 ft^3$	14.5
LPG (10^3 gal)	7,758	1.85 lbs/10^3 gal[3]	7.2
TOTAL			265.7
Forsyth			
Bituminous Coal (tons)	300	14 lbs/ton[2]	2.1
Residual Oil (10^3 gal)	700	23 lbs/10^3 gal	8.1
Distillate Oil (10^3 gal)	3,032	15 lbs/10^3 gal	22.7
Natural Gas ($10^6 ft^3$)	757	10 lbs/$10^6 ft^3$	3.8
LPG (10^3 gal)	928	1.85 lbs/10^3 gal[3]	0.9
TOTAL			37.6
Guilford			
Bituminous Coal (tons)	423	14 lbs/ton[2]	3.0
Residual Oil (10^3 gal)	1,194	23 lbs/10^3 gal	13.7
Distillate Oil (10^3 gal)	420	15 lbs/10^3 gal	3.2
Natural Gas ($10^6 ft^3$)	2,944	10 lbs/$10^6 ft^3$	14.7
LPG (10^3 gal)	480	1.85 lbs/10^3 gal[3]	0.4
TOTAL			35.0

(1) Source: Reference 2.
(2) Spreader stoker furnace, 7% ash.
(3) 50% propane, 50% butane.

3. AREA SOURCE INDUSTRIAL FUEL USAGE

Using the fuel totals from Tables 3 through 5, county-side emissions from industrial fuel usage, not reported as point sources, were calculated as shown below. Emission factors for bituminous coal are based on those given in Reference 2 for general industrial boilers (10 - 100 x 10^6 Btu) and a reported ash content of 14%. Because there is no firm information concerning these area source boilers, the emission factors selected were considered by ES to be more appropriate than those for commercial and institutional boilers.

	Fuel Used	Emission Factor[1]	Emissions (tons/yr)
Mecklenburg			
Bituminous Coal (tons)	356	182 lbs/ton[2]	32.4
Residual Oil (10^3 gal)	0	23 lbs/10^3 gal	0
Distillate Oil (10^3 gal)	36,517	15 lbs/10^3 gal	273.9
Natural Gas ($10^6 ft^3$)	929	10 lbs/$10^6 ft^3$	4.6
LPG (10^3 gal)	8,242	1.75 lbs/10^3 gal	7.2
TOTAL			318.1
Forsyth			
Bituminous Coal (tons)	0	182 lbs/ton	0
Residual Oil (10^3 gal)	0	23 lbs/10^3 gal	0
Distillate Oil (10^3 gal)	6,528	15 lbs/10^3 gal	49.0
Natural Gas ($10^6 ft^3$)	1,248	10 lbs/$10^6 ft^3$	6.2
LPG (10^3 gal)	1,621	1.75 lbs/10^3 gal	1.4
TOTAL			56.6
Guilford			
Bituminous Coal (tons)	228	182 lbs/ton	20.7
Residual (10^3 gal)	652	23 lbs/10^3 gal	7.5
Distillate Oil (10^3 gal)	5,664	15 lbs/10^3 gal	42.5
Natural Gas ($10^6 ft^3$)	1,132	10 lbs/$10^6 ft^3$	5.7
LPG (10^3 gal)	1,423	1.75 lbs/10^3 gal	1.2
TOTAL			77.6

(1) Source: Reference 2.
(2) 14% ash.

4. INTERNAL FUEL COMBUSTION STATIONARY SOURCES

This source category includes stationary, off-highway equipment, such as gas turbines and reciprocating engines not included in the point source inventory. No such sources were found. (The Davidson pumping station operated by Transcontinental Gas Pipeline Corporation lies outside the AQMA.) However, the fuel consumed by these sources, if any, is included in the industrial fuel usage totals.

5. SOLID WASTE DISPOSAL AND INCINERATION

On-site incineration refers to disposal in a "small" incinerator, including backyard burners as well as industrial and commercial size incinerators. A sample telephone survey of companies which sell incinerators indicated that very few incinerators of any size are sold within the study areas. Those which have been sold lately are pathological incinerators. Local waste

disposal laws and the ready availability of land-fill and pulverization disposal methods incorporating truck pick-up make on-site incineration unlikely except for large installations.

Open burning refers to burning where the combustion products enter the atmosphere directly without first passing through a stack or chimney. In contrast to on-site incineration, open burning is currently practiced outside densely populated areas. Local air quality control agencies in the three counties have provided open burning estimates where possible. Guilford County cannot provide an estimate of total emissions from open burning but the assumptions made by Forsyth County officials can also be applied to Guilford County. These counties are adjacent and have very similar waste disposal systems, as described in the Piedmont Triad Council of Governments, Regional Solid Waste Management Study. This study was used to make the necessary adjustments when extrapolating Forsyth County disposal practices to Guilford County.

Mecklenburg County

Open burning in the County was stringently controlled by the local agency in 1973 and was estimated to be 98% effective. Ninety open burning permits were issued:

- o 42 agricultural permits (2-3 acres of undergrowth and few trees)
- o 48 diseased tree permits (10-20 trees each)

At five tons/acre (1/4 the value given in Reference 1 because of the limited number of trees involved) and with an emission factor of 17 lbs/ton, the agricultural permits resulted in emissions of:

$$\frac{42 \text{ 1/year} \times 2.5 \text{ acres} \times 5 \text{ tons/acre} \times 17 \text{ lbs/ton}}{2{,}000 \text{ lbs/ton}} = 4.5 \text{ tons/year.}$$

With an estimated weight of three tons/tree for the large trees involved in the diseased tree permits and the same emission factor, total emissions from this source resulted in emissions of:

$$\frac{48 \text{ 1/year} \times 15 \text{ trees} \times 3 \text{ tons/tree} \times 17 \text{ lbs/ton}}{2{,}000 \text{ lbs/ton}} = 18.4 \text{ tons/year.}$$

Estimates of emissions in Mecklenburg County from fire training and automobile fires are made by population proportion from these emissions in Forsyth County (see following paragraphs).

$$\frac{\text{Population of Mecklenburg}}{\text{Population of Forsyth}} \times \frac{\text{Fire Training + Automobile Emissions Forsyth}}{\text{2,000 lbs/ton}}$$

$$\frac{378,434}{222,276} \times \frac{10,530}{2,000} = 9.0 \text{ tons/year}$$

According to county permit files, there were 800 tons of refuse burned in single-chamber incinerators, 4,500 tons of refuse burned in multi-chamber incinerators, and 60 tons of refuse burned in pathological incinerators. Using emission factors from Reference 2 of 15 lbs/ton, 7 lbs/ton, and 8 lbs/ton, respectively, gives 22.0 tons/year total emissions.

In summary:

Open Burning	31.9 tons/year
Incineration	22.0 tons/year
TOTAL	53.9 tons/year

Forsyth County

Estimates of emissions from open burning were made by the Forsyth County local agency:

Fire training	9,435 lbs/year
Automobile fires	1,095
Land clearing	82,238
Brush clearing	2,601
Grass, wood, & brush fires	539
Garbage	26,208
Leaves	3,570
Miscellaneous	2,000
TOTAL	127,686 lbs/year
	63.8 tons/year

Similarly, the local agency provided the following nonpoint source incinerator inventory:

Number	47
Average Capacity	350 lbs
Number of firings	6/week

For multiple chamber incinerators, the emission factor is 7 lbs/ton of charge (Reference 2). Total emissions are calculated to be:

$$\frac{47 \times 350 \text{ lbs/charge} \times 6 \text{ charges/week} \times 52 \text{ weeks/yr} \times 7 \text{ lbs/ton}}{2{,}000 \text{ lbs/ton} \times 2{,}000 \text{ lbs/ton}} = 9.0 \text{ tons/yr}$$

In summary:

Open Burning	63.8 tons/year
Incineration	9.0 tons/year
TOTAL	72.8 tons/year

Guilford County

The Guilford County Department of Public Health was unable to provide incineration and open burning emission estimates. Estimates for Guilford County were made by extrapolating from Forsyth County based on population and regular waste pick-up by refuse collectors determined from the Regional Solid Waste Management Study. The population ratio between Guilford and Forsyth is 1.361; ratio of areas not served by waste pick-up is 1.591. This is additionally a measure of rural effect which can be applied to the agricultural related open burning, land and brush clearing.

The following emissions were calculated from the Forsyth data by use of the ratios.

Fire training	9,435 x 1.361 =	12,841 lbs/year
Automobile fires	1,095 x 1.361 =	1,490
Land clearing	82,238 x 1.591 =	130,841
Brush clearing	2,601 x 1.591 =	4,138
Grass, wood, & brush fires	539 x 1.591 =	858
Garbage	26,208 x 1.591 =	41,697
Leaves	3,570 x 1.361 =	4,859
Miscellaneous	2,000 x 1.361 =	2,722
Incineration	18,000 x 1.361 =	24,498
TOTAL		223,944 lbs/year

In summary:

Open Burning	99.7 tons/year
Incineration	12.2 tons/year
TOTAL	111.9 tons/year

6. OFF-ROAD VEHICLES

Six classes of vehicles were considered:

- o Gasoline farm tractors;
- o Small gasoline engines;

- o Diesel farm tractors;
- o Diesel construction equipment;
- o Miscellaneous diesel engines; and
- o Diesel railroad operations.

Reference 9 provides information on the number of farm tractors operated in 1969 in the three counties: 782, 1727 and 3116 for Mechlenburg, Forsyth and Guilford, respectively. Chapter III, Section 14 describes a method of estimating 1973 tilled cropland from the 1969 tilled acreage from Reference 9. Assuming the same decay factors that apply to tilling are also appropriate for tractors the total number of tractors in the three counties would be 636, 1549, and 2698, respectively. Reference 3 suggests that fuel usage per tractor is 1,000 gallons/tractor-year. Using these data, fuel usage (gasoline and diesel combined) by county can be calculated:

- o Mechlenberg County - 636,000
- o Forsyth County - 1,549,000
- o Guilford County - 2,698,000

These data were reviewed by the U. S. Department of Agriculture County Agents concerned. Each cautioned against using the data because of the large number of tractors not included in Reference 9. Furthermore, in their opinions, records of tax-free fuel use do not reflect actual farm fuel usage because of the large number of infrequently used tractors that are not reported in conjunction with this tax-saving feature.

The agents provided the following estimates of fuel usage:

	Gasoline	Diesel	Total
Mechklenburg County	203,000	137,000	340,000
Forsyth County	1,035,000	1,010,000	2,045,000
Guilford County	2,277,000	2,222,000	4,499,000

In the cases of Forsyth and Guilford counties the estimates exceed those determined from the Reference 9/Reference 3 method, while the opposite is the case in Mecklenburg. This was explained by the Mecklenburg County Agent as a result of different agricultural practices in Forsyth and Guilford Counties and the prevalence of part-time farmers in Mecklenburg County. The values provided by the agents were considered more accurate and thus were used in the emission inventory.

Small gasoline engine fuel usage was calculated from the factor 13 gallons/person-year given in Reference 3 based on 1973 population figures supplied by planning agencies.

- o Mecklenburg County - 378,434
- o Forsyth County - 222,276
- o Guilford County - 302,444

References 1 and 3 suggest a factor of 5,000 gallons of diesel construction equipment fuel usage per non-building construction employee. This value appears too large when compared with off-highway diesel consumption given in the MIS. Likewise, the value of 7.4 gallons/person-year for miscellaneous diesel fuel consumption also appears too large. Consequently, the two sources were combined and calculated as follows:

$$\text{County Total} = \left(\text{State off-highway from MIS} \times \frac{\text{County NBC employee}}{\text{State NBC employee}}\right) - \text{County Tractor Use}$$

Non-building construction employment is obtained from Reference 11.

Mecklenburg County

$$\left(3.09 \times 10^7 \times \frac{12,493}{80,480}\right) - 137,000 = 4,661.504 \text{ gallons/year}$$

Forsyth County

$$\left(3.09 \times 10^7 \times \frac{3,942}{80,480}\right) - 1,010,000 = 504,104 \text{ gallons/year}$$

Guilford County

$$\left(3.09 \times 10^7 \times \frac{7,928}{80,480}\right) - 2,222,000 = 823,109 \text{ gallons/year}$$

Fuel use data available from the railroad operating companies was inadequate as a basis for the emission inventory because the data could not be related to the locations in which it was used. Road haul operating data given in Table 6 was obtained from the railroads for use in calculating fuel usage.

TABLE 6

RAILROAD ROAD HAUL OPERATING DATA

	Train Miles per Day
Mecklenburg County	
Seaboard	183.4
Southern	542.4
Norfolk Southern	30.8
TOTAL	756.6
Forsyth County	
Norfolk and Western	48.8
Southern	120.6
Winston-Salem Southbound	13.8
TOTAL	183.2
Guilford County	
Southern	971.9

Reference 5 provides a method for estimating the fuel used in road haul operations. It is estimated that 64.4×10^6 locomotive hours were used for all road haul service at 0.46 lb fuel/bhp hour and a load factor of 0.38. At the nation-wide average speed of 20 mph, total train hours were $451 \times 10^6/20 = 22.6 \times 10^6$ and locomotives/train were 64.4/22.6 = 2.8. Using the nation-wide average value for road haul locomotive power, 2,278 hp, and the load factor, a value for fuel consumption/train mile can be calculated:

$$\frac{2.8 \text{ loco/train} \times 2{,}278 \text{ bhp/loco} \times 0.38 \times 0.46 \text{ lb fuel/bhp-hour}}{7.12 \text{ lbs/gal} \times 20 \text{ miles/hour}} = 7.8 \frac{\text{gallons}}{\text{train mile}}$$

Reference 4 provides information on total fuel consumption by railroads in the United States including road haul operations as well as switching operations and miscellaneous fuel usage; and information on total train miles travelled. These two values, $4{,}071 \times 10^6$ gallons consumed and 451×10^6 train miles travelled, permit estimating fuel use per road haul train mile in which switching operations and miscellaneous fuel usage are included. This value is 9.0 gallons/train mile ($4{,}071 \times 10^6 : 451 \times 10^6$). It can be concluded that approximately 8.0 gallons/road haul train mile is consumed in road haul operations, and another 1.0 gallons/road haul train mile is consumed in yard operations.

All off-road vehicle fuel consumption and emissions are summarized in Table 7.

TABLE 7

OFF-ROAD EMISSION SUMMARY

	Fuel Use 10^3 gallons	EF[1] lbs/10^3 gal	Emissions tons/year
Mecklenburg County			
Gasoline farm tractors[2]	203	8[1]	0.8
Small gasoline engines[2]	4,920	10.7[2]	26.3
Diesel farm tractors	137	45.7[1]	3.1
Diesel construction equip.[3]	4,662	26.1[3]	60.8
Miscellaneous diesel engines[3]			
Diesel railroad engines	2,209	25[1]	27.6
Railroad yard operations	276	25[1]	3.5
Forsyth County			
Gasoline farm tractors[2]	1,035	8	4.1
Small gasoline engines[2]	2,890	10.7	15.5
Diesel farm tractors	1,010	45.7	23.1
Diesel construction equip.[3]	504	26.1	6.6
Miscellaneous diesel engines[3]			
Diesel railroad engines	535	25	6.7
Railroad yard operations	67	25	0.8
Guilford County			
Gasoline farm tractors[2]	2,277	8	9.1
Small gasoline engines[2]	3,932	10.7	21.0
Diesel farm tractors	2,222	45.7	50.8
Diesel construction equip.[3]	823	26.1	10.7
Miscellaneous diesel engines[3]			
Diesel railroad engines	2,838	25	35.5
Railroad yard operations	355	25	4.4

(1) Source: Reference 2.
(2) Source: Reference 2 - 90% four-stroke engines, 10% two-stroke engines.
(3) Source: Reference 2 - Mean of all equipment types.

7. ROAD VEHICLES

Total vehicle miles travelled (VMT) by counties, and the light duty vehicle (LDV) and heavy duty vehicle (HDV) mix were provided by the North Carolina Department of Transportation and Highway Safety. These data are summarized in Table 8. In actual fact, the State data combined interstate and primary highways into one classification. The VMT for interstate highways was determined link by link from the 1973 ADT counts from traffic maps and substracted from the total class.

The mix of heavy duty diesel vehicles (HDDV) and heavy duty gasoline vehicles (HDGV) was obtained from Bureau of Census data. These data are summarized in Table 9.

These data permitted calculating VMT by three vehicle classes for each county. The results are shown in Table 10.

Total county-wide emissions were calculated using emission factors of 0.54 g/mile, 0.85 g/mile, and 13 lbs/1,000 gallons at 5.1 miles/gal for LDV, HDGV, HDDV, respectively, from Reference 2.

Mecklenburg County

$$\text{LDV} = \frac{1{,}802 \times 0.54 \times 10^6}{454 \times 2{,}000} = 1{,}072.6 \text{ tons/year}$$

$$\text{HDGV} = \frac{111.2 \times 0.85 \times 10^6}{454 \times 2{,}000} = 104.2 \text{ tons/year}$$

$$\text{HDDV} = \frac{98.8 \times 13 \times 10^6}{1{,}000 \times 5.1 \times 2{,}000} = 125.9 \text{ tons/year}$$

Forsyth County

$$\text{LDV} = \frac{952.9 \times 0.54 \times 10^6}{454 \times 2{,}000} = 567.2 \text{ tons/year}$$

$$\text{HDGV} = \frac{65.8 \times 0.85 \times 10^6}{454 \times 2{,}000} = 61.7 \text{ tons/year}$$

$$\text{HDDV} = \frac{58.3 \times 13 \times 10^6}{1{,}000 \times 5.1 \times 2{,}000} = 74.3 \text{ tons/year}$$

TABLE 8

10^6 VMT AND LDV/HDV MIX[1]

		Interstate Highways	Primary Highways	Secondary Roads	Municipal Streets
Mecklenburg	VMT	341	823	556	292
Forsyth	VMT	260	363	297	157
Guilford	VMT	492	452	451	238
%	HDV	25	10	5	5

(1) Source: North Carolina Department of Transportation and Highway Safety.

TABLE 9

HEAVY DUTY TRUCK STATISTICS FOR NORTH CAROLINA

	10^6 VMT[1]	HDDV (%)[1]	10^6 HDDVMT
Single Unit 2-axle	1,224	0.3	3.7
Single Unit 3-axle	228	20.7	47.2
Combination 3-axle	211	30.4	64.1
Combination 4-axle	532	70.3	374.0
Combination 5-axle	1,174	93.8	1,101.2
All Others	10	93.8	9.4
Total	3,379		1,600
	TOTAL HDDVMT = $\frac{1,600}{3,379}$ = 47%		

(1) Source: Reference 6.

TABLE 10

10^6 VMT BY VEHICLE CLASS

		Interstate Highway	Primary Highway	Secondary Road	Municipal Street	Total
Mecklenburg	LDVMT	255.7	740.7	528.2	277.4	1,802.0
	HDGVMT	45.2	43.6	14.7	7.7	111.2
	HDDVMT	40.1	38.7	13.1	6.9	98.8
Forsyth	LDVMT	195.0	326.7	282.1	149.1	952.9
	HDGVMT	34.5	19.2	7.9	4.2	65.8
	HDDVMT	30.5	17.1	7.0	3.7	58.3
Guilford	LDVMT	369.0	406.8	428.4	226.1	1,430.3
	HDGVMT	65.2	24.0	12.0	6.3	107.5
	HDDVMT	57.8	21.2	10.6	5.6	95.2

Guilford County

$$LDV = \frac{1,430.3 \times 0.54 \times 10^6}{454 \times 2,000} = 851.4 \text{ tons/year}$$

$$HDGV = \frac{107.5 \times 0.85 \times 10^6}{454 \times 2,000} = 100.7 \text{ tons/year}$$

$$HDDV = \frac{95.2 \times 13 \times 10^6}{1,000 \times 5.1 \times 2,000} = 121.3 \text{ tons/year}$$

8. AIRCRAFT AND AIRPORT OPERATIONS

Aircraft operating data were obtained from FAA reports for the four statistical categories for which data are collected: air carrier, air taxi, military, and general aviation. These categories were further broken down into subcategories by information provided locally by airport managers, airline operating schedules, and landing fee reports. Operations at non-FAA controlled airports were estimated by the FAA regional office at Douglas Airport, Charlotte. Tables 11 through 13 are summaries of data collected and emissions.

9. VESSELS

Recreational boating data were provided by the North Carolina Department of Recreation. Only Mecklenburg County, in the Lake Norman-Catawba River recreational area, has significant boating activity. Less than 500 boats regularly use the Belew Creek recreational area in Forsyth County. All boats are powered by gasoline engines with exhausts below the waterline.

Boating years were calculated from registration of 1973 boats with engines of at least 10 HP, a factor of 1.25 to account for smaller engines, and an estimate of the percentage of boats in each county which use the Lake Norman complex provided by the Department of Recreation, Boat and Water Safety Division. The results are summarized in Table 14.

To determine fuel usage, the factor 160 gallons/boat-year (Reference 3) was used. It was suggested that because of higher prices at the marinas fuel dealer sales would not accurately represent fuel used on the Lake. An estimate of total vessel gasoline usage in Mecklenburg County is:

$$23,546 \times 160 = 3,767 \times 10^3 \text{ gals/year}$$

TABLE 11

AIRCRAFT OPERATIONS, MECKLENBURG COUNTY

	Operations/ Year	No. of Engines	Landing Takeoffs	Emission Factors[1] (lbs/engine-LTO)	Emissions (lbs/year)
DOUGLAS AIRPORT					
Air Carrier	63,675				
Jumbo Jet		4	0	1.30	0
Long-Range Jet		4	650	1.21	3,146
Medium-Range Jet		2¼	27,000	0.41	24,908
Turbo-Prop		2	4,000	1.10	8,800
Air Taxi	6,289				
Piston Transport		1½	1,000	0.56	840
Turbo-Prop		2	2,000	0.20	800
Military	5,109				
Transport		3	2,250	1.10	7,425
Piston		1	250	0.28	70
Jet		1	50	0.31	16
General Aviation	117,268				
Business Jet		2	5,850	0.11	1,287
Turbo-Prop		2	1,150	0.20	460
Piston Transport		2	2,950	0.56	3,304
Helicopter		1	2,950	0.25	737
Piston		1	45,750	0.02	915
DOUGLAS AIRPORT TOTAL					52,708
WILLGROVE AIRPORT	21,600				
GA Piston		1	10,800	0.02	216
BRADFORD AIRPORT	480				
GA Piston		1	240	0.02	5
DELTA AIRPORT	120				
GA Piston		1	60	0.02	1
MECKLENBURG COUNTY TOTAL					52,930

(1) Source: Reference 2.

TABLE 12

AIRCRAFT OPERATIONS, FORSYTH COUNTY

	Operations/ Year	No. of Engines	Landing Takeoffs	Emission Factors[1] (lbs/engine-LTO)	Emissions (lbs/year)
SMITH REYNOLDS AIRPORT					
Air Carrier	10,228				
Jumbo Jet		4	0	1.30	0
Long-Range Jet		4	0	1.21	0
Medium-Range Jet		2	1,590	0.41	1,304
Turbo-Prop		2	3,630	1.10	7,986
Air Taxi	16				
Piston Transport		1½	4	0.56	3
Turbo-Prop		2	4	0.20	2
Military	973				
Transport		3	0	1.10	0
Piston		1	24	0.28	7
Jet		1	0	0.31	0
Turbo-Prop		4	243	1.10	1,069
Helicopter		1	219	0.25	55
General Aviation	53,000				
Business Jet		2	2,650	0.11	583
Turbo-Prop		2	4,000	0.20	1,600
Piston Transport		2	1,050	0.56	1,176
Helicopter		1	250	0.25	63
Piston		1	18,550	0.02	371
SMITH REYNOLDS AIRPORT TOTAL					14,219
FORSYTH COUNTY TOTAL					14,219

(1) Source: Reference 2.

TABLE 13

AIRCRAFT OPERATIONS, GUILFORD COUNTY

	Operations/ Year	No. of Engines	Landing Takeoffs	Emission Factors[1] (lbs/engine-LTO)	Emissions (lbs/year)
GREENSBORO-HIGH POINT AIRPORT					
Air Carrier	32,941				
Jumbo Jet		4	0	1.30	0
Long-Range Jet		4	0	1.21	0
Medium-Range Jet		2½	12,525	0.41	12,838
Turbo-Prop		2	3,975	1.10	8,745
Air Taxi	1,138				
Piston Transport		1½	250	0.56	210
Turbo-Prop		2	325	0.20	130
Military	3,282				
Transport		3	1,200	1.10	3,960
Piston		1	400	0.28	112
Jet		1	50	0.31	16
General Aviation	106,350				
Business Jet		2	5,300	0.11	1,166
Turbo-Prop		2	1,050	0.20	420
Piston Transport		2	2,675	0.56	2,996
Helicopter		1	2,650	0.25	663
Piston		1	41,500	0.02	830
GREENSBORO-HIGH POINT AIRPORT TOTAL					32,086
AIRHARBOR AIRPORT	2,400				
GA Piston		1	1,200	0.02	24
MAY AIRPORT	1,200				
GA Piston		1	600	0.02	12
CAUSEY AIRPORT	3,000				
GA Piston		1	1,500	0.02	30
MID-ATLANTIC AIRPORT	480				
GA Piston		1	240	0.02	5
GUILFORD COUNTY TOTAL					32,157

(1) Source: Reference 2.

TABLE 14

BOATING YEARS AT THE LAKE NORMAN-CATAWBA RIVER RECREATION AREA BY COUNTY OF REGISTRATION

County	No. Registered Boats	Total Boats	% Using Lake Norman	Total Using Lake Norman
Alexander	419	524	55	288
Anson	160	200	40	80
Burke	1,174	1,468	20	294
Cabarrus	1,954	2,443	35	855
Caldwell	1,015	1,269	20	254
Catawba	2,743	3,429	65	2,229
Cleveland	1,114	1,393	40	557
Davidson	2,202	2,753	25	688
Davie	297	371	25	93
Forsyth	3,081	3,851	25	963
Gaston	2,744	3,430	80	2,744
Guilford	4,360	5,450	20	1,090
Iredell	2,004	2,505	75	1,879
Lincoln	1,052	1,315	80	1,052
Mecklenburg	7,465	9,331	85	7,932
Montgomery	402	502	20	100
Randolph	1,124	1,405	20	281
Richmond	445	556	20	111
Rowan	1,821	2,276	25	569
Stanly	1,446	1,808	35	633
Union	629	786	50	393
Wilkes	436	545	25	136
Yadkin	218	273	20	55
Out-of-State Total				270
TOTAL				23,546

Since particulate emissions from boats with exhausts below the water line are negligible (Reference 2), emissions from this source category would be insignificant.

10. STRUCTURAL FIRES

City and county fire departments were able to provide accurate information on the number of structural fires and the total dollar loss. These data are listed in Table 15.

The loss in Mecklenburg County is the equivalent of 76 single family dwellings at $30,000 per dwelling. It is estimated (Reference 7) that such a $30,000 dwelling in North Carolina would include:

10,840 board feet of lumber	= 791 ft^3
5,380 ft^2 of 3/8" plywood	= 168 ft^3
TOTAL	959 ft^3

plus five tons of furnishings.

TABLE 15

STRUCTURAL FIRES AND LOSSES

County	No. Fires	Fires/1,000 Population[1]	Loss
Mecklenburg	1,371	3.6	$2,275,741
Forsyth	1,576	7.1	1,774,610
Guilford	1,412	4.7	2,770,382

(1) As compared to the nation-wide average of four structural fires/1,000 population as given in Reference 1.

At a mean density of 47 lbs/ft^3, this is equivalent to 22.5 tons/house. Reference 2 provides a particulate matter emission factor for open burning of wood refuse of 17 lbs/ton of wood burned. Total emissions from structural fires, calculated by this method are given below:

Mecklenburg County

$$\frac{17 \text{ lbs/ton} \times (22.5 + 5.0) \text{ tons/house} \times 76 \text{ houses}}{2{,}000 \text{ lbs/ton}} = 17.7 \text{ tons/year}$$

The emission factor based on dollar loss is 15.6 lbs/$1,000 loss.

Forsyth County

$$\frac{15.6 \times 1{,}775}{2{,}000} = 13.8 \text{ tons/year}$$

Guilford County

$$\frac{15.6 \times 2{,}770}{2{,}000} = 21.6 \text{ tons/year}$$

11. AGRICULTURAL BURNING

Agricultural burning is not practiced in any of the three counties. Disposal of agricultural wastes by open burning is included in other source categories.

12. UNPAVED ROAD OPERATIONS

The North Carolina Department of Transportation and Highway Safety provided the data concerning the number of miles of unpaved roads by county shown in Table 16.

TABLE 16

UNPAVED ROAD MILEAGE

County	Rural	Municipal	Total
Mecklenburg	140.20	4.08	144.28
Forsyth	237.20	2.67	239.87
Guilford	450.10	3.74	453.84

Although traffic counts by road link initially were not available for unpaved roads, the Department estimated an average ADT of 65 for all roads in all counties.

An emission factor for dirt roads was determined by the methods outlined in Reference 8.

The formula suggested is: $EF = 0.81\ s \left(\frac{S}{30}\right)$

where EF is the emission factor (lbs/vehicle mile), s is the silt content of road surface material (%), and S is the vehicle average speed (mph).

This equation estimates the factor for particles $\leq$ 100 μm. Since a more realistic cutoff value for truly suspended particulates would be nearer 30 μm, 60% of the mass (Reference 8, page 44), the equation was modified by that factor. Furthermore, as suggested in the reference, emissions would not occur on the days with precipitation $\geq$ 0.01 inches. The resulting modified equation is:

$$EF = 0.60 \left[\frac{365 - d}{365}\right] \left[0.81\ s \left(\frac{S}{30}\right)\right]$$

where d is the number of days with precipitation $\geq$ 0.01 inches.

Using the following parameters:

s = 15%, a mostly gravel road

S = 25

d = 112

$$EF = 0.60 \left(\frac{365 - 112}{365}\right) \left(\frac{0.81 \times 15 \times 25}{30}\right) = 4.2 \text{ lbs/vehicle-mile}$$

This emission factor leads to what appears to be excessive values for total emissions:

Mecklenburg County

$$\frac{4.2 \text{ lbs/VMT} \times 144.28 \text{ miles} \times 65 \text{ VEH/day} \times 365 \text{ days/yr}}{2{,}000 \text{ lbs/ton}} = 7{,}188.4 \text{ tons/year}$$

Forsyth County

$$\frac{4.2 \times 239.87 \times 65 \times 365}{2{,}000} = 11{,}950.9 \text{ tons/year}$$

Guilford County

$$\frac{4.2 \times 453.84 \times 65 \times 365}{2{,}000} = 22{,}611.4 \text{ tons/year}$$

However, a simple box model of the form:

$$X = \frac{Q}{UDW}$$

where X is the concentration, Q is emission rate, U is wind speed, D is mixing depth, and W is the cross wind width of the county, leads to reasonable values of mean concentration. For Guilford County:

$Q = 6.49 \times 10^{8}$ µg/sec

U = 3.5 m/sec

D = 500 m

W = 32,000 m

$X = 11.6$ µg/m^3

X as calculated is a value smaller than the generally accepted background values.

Upon a later investigation, it was found that more detailed data were available from the North Carolina Department of Transportation and Highway Safety. Based on the revised traffic information, the Department of Natural and Economic Resources, through the allocation/apportionment procedure described in Chapter IV, Section 12 of this report concluded that the total baseline year emissions from the unpaved road category are as follows:

- Mecklenburg County: 7,116.5 tons/year
- Forsyth County: 15,665.0 tons/year
- Guilford County: 24,580.8 tons/year

These values are used in the remainder of this report.

13. UNPAVED AIRSTRIP OPERATIONS

All airstrips in the three counties are either asphalt or turf. However, Willgrove Airport in Mecklenburg County, with 10,800 LTO/year has a dirt taxiway parallel to the runway. The scale of operations at this airport would call for general use of this taxiway once for each LTO cycle.

Assuming a 2,000-foot landing rollout with an emission factor of 6.1 lbs/mile (the unpaved road emission factor equation not modified for rainy days) results in 12.5 tons/year emissions.

14. TILLING OPERATIONS

Acreage farmed by crop for each county was obtained for 1969 from Reference 9. These data are summarized in Table 17.

TABLE 17

HARVESTED CROPLAND 1969(1)
(Acres)

	Mecklenburg	Forsyth	Guilford
Corn	3,186	4,730	9,749
Sorghums	588	121	958
Wheat	850	1,652	3,873
Soybean	2,750	1,042	4,564
Cotton	1,100	0	72
Tobacco	0	2,988	6,547
Small Grains	1,829	1,763	4,829
Vegetables	200	273	586
TOTAL	10,503	12,569	31,178

(1) Source: Reference 9.

Estimates of county totals for 1973 were estimated from the state-wide relationship between decreasing acreage of farmland and increasing population:

Census of Agriculture
Land in farms 1964: 14,381,724 acres
Land in farms 1969: 12,733,751 acres

Estimated by Linear Interpolation/Extrapolation
Land in farms 1965: 14,052,129 acres
Land in farms 1970: 12,404,156 acres

General Population Characteristics, Bureau of Census
Population 1965: 4,811,927
Population 1970: 5,082,059

These data indicate that a 5.61% increase in population results in an 11.73% decrease in farmland on a state-wide basis.

These parameters are now used to project the county harvested cropland from 1969 to 1973:

	Population			Land in Farms	
	1970	1973	% Increase	% Decrease	% Decrease/yr
Mecklenburg County	354,656	378,434	6.70	14.01	4.67
Forsyth County	214,348	222,276	3.70	7.74	2.58
Guilford County	288,590	302,444	4.80	10.04	3.35

Harvested cropland by county is calculated for 1973:

Mecklenburg: 10,503 - (10,503 x 4 x 0.0467) = 8,541 acres

Forsyth: 12,569 - (12,569 x 4 x 0.0258) = 11,272 acres

Guilford: 31,178 - (31,178 x 4 x 0.0335) = 27,000 acres

Tilling schedules for the several cultivated crops were provided by the County Agents. In Mecklenburg County, all crops are tilled twice; there is no fall plowing. In Forsyth and Guilford Counties, tobacco is tilled four times and all other crops three times.

Reference 8 provided a method for estimating emission factors (EF) for tilling operations for particles $\leq$ 30 μm:

$$EF = \frac{1.12s\ (S/5.5)}{(PE/50)^2}$$

where s is the silt content of the surface soil (%), S is the implement speed (mph), and PE is the Thornthwaite precipitation-evaporation index. Parameters used in the equation are:

s = 26% (sandy loam soil)

S = 3.0

PE = 105

$$EF = \frac{1.12 \times 26 \times 3.0 \times (50)^2}{(105)^2 \times 5.5} = 3.6 \text{ lbs/acre}$$

Applying this emission factor and the data developed earlier (acreage tilled and tilling schedule) permits calculating total annual emissions.

Mecklenburg County

$$\frac{3.6 \times 8{,}541 \times 2}{2{,}000} = 30.7 \text{ tons/year}$$

Forsyth County

$$\frac{3.6 \times 8{,}592 \times 3}{2{,}000} + \frac{3.6 \times 2{,}680^{(1)} \times 4}{2{,}000} = 65.7 \text{ tons/year}$$

Guilford County

$$\frac{3.6 \times 21{,}330 \times 3}{2{,}000} + \frac{3.6 \times 5{,}670^{(1)} \times 4}{2{,}000} = 156.0 \text{ tons/year}$$

15. CONSTRUCTION OPERATIONS

Reference 8 recommends that an emission factor of 1.2 tons/acre-month of active construction sites be used as an upper value, i.e., appropriate for application in arid areas with watering for dust control. In an attempt to define the value somewhat better, the wind erosion equation was applied.

$$E_s = AIKCL'V'$$

where E_s = suspended particulate fraction of wind erosion losses of tilled fields, tons/acre/year

A = portion of total wind erosion losses that would be measured as suspended particulate, estimated to be 0.025

I = soil erodibility, tons/acre/year

K = surface roughness factor, dimensionless

C = climatic factor, dimensionless

L' = unsheltered field width factor, dimensionless

V' = vegetative cover factor, dimensionless.

(1) The ratio of tobacco cropland to total cropland is constant from 1969 to 1973.

The following values were taken from the above reference:

I = 86 (sandy loam soil)

K = 0.5 the minimum value. The surface roughness factor was developed for erosion from farmland. A construction site would be rough as compared to farmland.

C = 4

L' = 0.4

V' = 1.0 no vegetative cover

$$E_s = 1.72 \text{ tons/acre-year}$$

With the assumption of 20% effectiveness of control by watering and an exposure period of three months,

$$EF = 688 \text{ lbs/acre-year.}$$

Another approach is to modify the arid area emission factor for Las Vegas by the North Carolina-Las Vegas ratios of C values. On an annual basis:

$$C_{LV} = K \frac{W^3_{LV}}{PE^2_{LV}}$$

$$C_{NC} = K \frac{W^3_{NC}}{PE^2_{LV}}$$

$$\frac{C_{LV}}{C_{NC}} = \frac{9.7^3 \times 105^2}{8.0^3 \times 7^2} = 401$$

where W is wind speed.

$$EF_{NC} = \frac{1.2 \times 3 \times 2{,}000}{401} = 18 \text{ lbs/acre-year}$$

for a three-month construction period.

In calculating total construction activity emissions, we have chosen an emission factor of 18 lbs/acre-year for residential construction and 180 lbs/acre-year for all other construction. Table 18 shows the method of calculating emissions by county.

TABLE 18

CALCULATION OF CONSTRUCTION EMISSIONS

	State	Mecklenburg	Forsyth	Guilford
Contract Construction Employment[1]	125,754	16,895	5,559	12,338

	State[2]	Mecklenburg[3]	Forsyth[3]	Guilford[3]
Contract Value 10^6 Dollars		($)	($)	($)
TOTAL	2,465	331	109	242
Residential	1,425	191	63	140
Non-Residential	678	91	30	67
Non-Building	362	49	16	35

	Factor[4]	Mecklenburg	Forsyth	Guilford
Acres of Construction		(acres)	(acres)	(acres)
Residential	$8A/10^6\$$	1,528	504	1,120
Non-Residential	$2.7A/10^6\$$	246	81	181
Non-Building	$25A/10^6\$$	1,225	400	875
TOTAL		2,999	985	2,176

TOTAL EMISSIONS (tons/year)	Residential	Non-Residential	Non-Building	TOTAL
Mecklenburg	13.8	22.1	110.3	146.2
Forsyth	4.5	7.3	36.0	47.8
Guilford	10.1	16.3	78.8	105.2

(1) Source: County Business Patterns, 1973.
(2) Source: Statistical Abstracts, 1974.
(3) Apportioned in accordance with employment.
(4) Source: Development of Emission Factors for Fugitive Dust Sources.

16. FOREST MANAGEMENT BURNING

This is not practiced in any of the counties.

17. PAVED ROADS

Two emission factors[1] have been suggested both based on VMT. The Seattle study suggested an emission factor of 1.75 g/VMT for clean streets. This leads to total emissions as follows:

Mecklenburg County: $1.75 \times 2{,}012 \times 10^{6}$ VMT/yr x 253/365 days with no rain x 1.102×10^{-6} tons/gram = 2,689.5 tons/year

Forsyth County: 1,439.7 tons/year

Guilford County: 2,182.9 tons/year

The Chicago study concluded that only 25% of motor vehicle impact can be attributed to exhaust emissions.

Mecklenburg County:

$\frac{0.34}{0.54} \frac{\text{LDV exhaust EF}}{\text{LDV total EF}} \times 1{,}072.6^{(2)}$ = 675.3 tons/year

$\frac{0.65}{0.85} \frac{\text{HDGV exhaust EF}}{\text{HDGV total EF}} \times 104.2^{(2)}$ = 79.7 tons/year

$\frac{1.00}{1.20} \frac{\text{HDDV exhaust EF}}{\text{HDDV total EF}} \times 125.9^{(2)}$ = 104.9 tons/year

Total Exhaust Emissions = 859.9 tons/year

Total Vehicle Impact $\frac{859.9}{0.25}$ = 3,439.6

Less Wear & Exhaust Emissions[2] = 1,302.7

Mecklenburg Paved Road Emissions = 2,136.9 tons/year

Forsyth Paved Road Emissions = 1,161.6 tons/year

Guilford Paved Road Emissions = 1,783.2 tons/year

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(1) The two studies referenced here were from unpublished papers provided to Engineering-Science, Inc. by EPA, Region IV.

(2) From Page 20.

We have selected the emissions calculated from the results of the Seattle study since it was based on actual measured concentration, albeit by somewhat questionable means. Allocation of this category to counties was in accordance with the allocation of VMT.

Further study by the Department of Natural and Economic Resources, resulting primarily from questions raised during preliminary dispersion modeling and the question of municipal street cleaning methods and frequencies as they might vary among the three counties, led to conclusions that the emission factor would not be constant between the counties. It was determined that the value for the factor in Mecklenburg County should be slightly greater than 4 g/VMT where vacuum street cleaning is practiced and approximately 6 g/VMT in Forsyth and Guilford Counties where vacuum cleaning is not practiced. It was felt that these emission factors, as averages, would not need a correction for rainy days.

These factors led to the emissions given below which are used hereafter in the report.

- Mecklenburg County: 9,413.13 tons/year
- Forsyth County: 7,198.5 tons/year
- Guilford County: 10,914.5 tons/year

18. WILD FOREST FIRES

There were no wild forest fires in 1973 in either Mecklenburg or Forsyth Counties. In Guilford County, there were 15 fires which consumed a total of 24 acres of thinly forested and brushy growth. Using the factor of 10 tons/acre of burned material and an emissions factor of 17 lbs/ton from Reference 2, total emissions are calculated to be:

$$\frac{24 \times 10 \times 17}{2,000} = 2.0 \text{ tons/year}$$

Of the 15 fires, 9 consumed less than 1/4 acre and 6 consumed from 1/4 to 10 acres. The small fire emissions (0.02 tons/year each) and the large fire emissions (0.31 tons/year each) were assigned directly to the grid square in which they occurred.

19. AREA SOURCE PROCESS LOSSES

Area source process loss emissions were provided by the Department of Natural and Economic Resources as follows:

- Mecklenburg County: 60.0 tons/year
- Forsyth County: 32.0 tons/year
- Guilford County: 121.0 tons/year

20. COUNTY SUMMARIES

Table 19 summarizes county total emissions.

TABLE 19

AREA SOURCE EMISSION SUMMARY

(tons/year)

	Mecklenburg	Forsyth	Guilford
Residential Fuel	222.1	199.9	373.7
C & I Fuel	265.7	37.6	35.0
Industrial Fuel	318.1	56.6	77.6
Internal Fuel Combustion	0	0	0
Open Burning	31.9	63.8	99.7
Incineration	22.0	9.0	12.2
Farm Tractors	3.9	27.2	59.9
Small Gasoline Engines	26.3	15.5	21.0
Diesel Construction	60.8	6.6	10.7
Railroad Engines	27.6	6.7	35.5
Railroad Yards	3.5	0.8	4.4
LDV	1,072.6	567.2	851.4
HDGV	104.2	61.7	100.7
HDDV	125.9	74.3	121.3
Aircraft	26.5	7.1	16.1
Vessels	0	0	0
Structural Fires	17.7	13.8	21.6
Agricultural Burning	0	0	0
Unpaved Roads	7,116.5	15,665.0	24,580.8
Unpaved Airstrips	12.5	0	0
Tilling	30.7	65.7	156.0
Construction	146.2	47.8	105.2
Forest Management	0	0	0
Paved Roads	9,413.3	7,198.5	10,914.5
Wild Forest Fires	0	0	2.0
Process Loss	60.0	32.0	121.0
TOTAL AREA SOURCES	19,108.0	24,156.8	37,720.3

NATIONAL EMISSIONS DATA SYSTEM (NEDS)
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR PROGRAMS

AREA SOURCE
Input Form
Date _____

Name of Person
Completing Form _____

MECKLENBURG

State	County	AQCR
1 2	3 4 5 6	7 8 9
34	2 5 8 0	1 6 7

Year of Record	Particulate	SO_2	NO_x	HC	CO	Sulfur Content (%) Anth Coal	Sulfur Content (%) Bitum Coal	Sulfur Content (%) Dist Oil	Sulfur Content (%) Resid Oil	Ash Content (%) Anth Coal	Ash Content (%) Bitum Coal	Residential Fuel: Anth 10^1 tons	Bitumin 10^1 tons	Dist Oil 10^4 Gal	Resid Oil 10^4 Gal	Nat Gas 10^7 ft^3	Wood 10^2 tons	Action	cd
10 11	12 13 14 15 16	17 18 19 20 21	22 23 24 25 26	27 28 29 30 31	32 33 34 35	36 37	38 39	40 41	42 43	44 45 46	47 48 49	50 51 52 53	54 55 56 57 58	59 60 61 62 63	64 65 66 67 68	69 70 71 72 73	74 75 76 77	78 79	80
73	0 0 1 4 2					▲	▲	▲	▲	0 0 0	0 0 7	2 0 0 0	0 0 3 7	2 0 2 5	9 6 0 0 0	0 0 0 5 7	4 0 0 2	A	A	1

Commercial and Institutional Fuel: Anth 10^1 tons	Bitumin 10^1 tons	Dist Oil 10^4 Gals	Resid Oil 10^1 Gals	Nat Gas 10^7 ft^3	Wood 10^2 tons	Industrial Fuel: Anth Coal 10^1 tons	Bitum Coal 10^1 tons	Coke 10^1 tons	Dist Oil 10^4 Gals	Resid Oil 10^4 Gals	Nat Gas 10^7 Ft^3	Wood 10^2 tons	Process Gas 10^7 ft^3	Action	cd
10 11 12 13 14	15 16 17 18 19	20 21 22 23 24	25 26 27 28 29	30 31 32 33 34	35 36	37 38 39 40 41	42 43 44 45 46	47 48 49 50 51	52 53 54 55 56	57 58 59 60 61	62 63 64 65 66	67 68 69 70 71	72 73 74 75 76	77 78	79 80
0 0 0 0 0	0 1 0 6 9	0 1 6 7 4	0 0 3 7 9	0 3 6 8	0 0	0 0 0 0 0	0 0 0 3 6	0 0 0 0	0 3 6 5 2	0 0 0 0 0	0 0 1 7 5	0 0 0 0 0	0 0 0	A	A	2

On Site Incineration: Residential 10^1 tons	Industrial 10^2 tons	Comm Inst 10^2 tons	Open Burning: Residential 10^2 tons	Industrial 10^2 tons	Comm I Instit 10^2 tons	Gasoline Fuel: Light Vehicle 10^3 Gals	Heavy Vehicle 10^3 Gals	Off Hiway 10^3 Gals	Diesel Fuel: Heavy Vehicle 10^3 Gals	Off Hiway 10^4 Gals	Rail Locomotive 10^4 Gals	County Population 10^3	Density Code	Action	cd
10 11 12 13 14	15 16 17 18 19	20 21 22 23 24	25 26 27 28 29	30 31 32 33 34	35 36 37 38 39	40 41 42 43 44	45 46 47 48 49	50 51 52 53 54	55 56 57 58 59	60 61 62 63 64	65 66 67 68 69	70 71 72 73 74	75 76 77	78 79	80
0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 1 3 2 5	0 0 1 3 2	3 8 0 5 1	2 3 1 1 9	3 7 3 4 8	0 0 0 0 2	4 9 9 0 3	6 5 7	A	A	3

Aircraft: Military LTO CYC 10^1	Civil LTO CYC 10^1	Commercial LTO CYC 10^1	Vessels: Anth Coal 10^1 tons	Diesel Oil 10^4 Gals	Resid Oil 10^4 Gals	Gasoline 10^3 Gals	Evaporation: Solvent Purchased tons yr	Gasoline Marketed 10^5 Gals	Measured Vehicle Miles: Limited Access Road 10^4 Miles	Rural Roads 10^4 Miles	Suburban Roads 10^4 Miles	Urban Roads 10^4 Miles	Action	cd
10 11 12 13 14	15 16 17 18 19	20 21 22 23 24	25 26 27 28 29	30 31 32 33 34	35 36 37 38 39	40 41 42 43 44	45 46 47 48 49	50 51 52 53 54	55 56 57 58 59	60 61 62 63 64	65 66 67 68 69	70 71 72 73 74	75 76 77	78 79	80
0 0 2 6 0	6 9 7 3	0 3 4 9 8	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	3 7 6 7			0 3 4 1 0	0 0 8 2 3	0 0 0 5 5	6 0 0 0 0	A	A	4

Dirt Roads Traveled 10^3 Miles	Dirt Air Strips LTO CYCLES	Construction Land Area 10^3 Acres	Rock Handling & Storing 10^3 tons	Forest Fires: Area Acres	Quant ton acre	Slash Burning: Area Acres	Quant tons acre	Frost Control: Orchard Heaters 10^3	Days Fired days yr	Structure Fires # / year	Coal Refuse Burning: Size of Bank 10^3 yard^3	# year	Action	cd
10 11 12 13 14	15 16 17 18 19	20 21 22 23 24	25 26 27 28 29	30 31 32 33 34	35 36 37 38 39	40 41 42 43 44	45 46 47 48 49	50 51 52 53 54	55 56 57 58 59	60 61 62 63 64	65 66 67 68 69	70 71 72 73 74	75 76 77	78 79	80
0 0 0 5 5	7 5 1 0 8	0 0 0 0 0	3	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	1 3 7 1 0	0 0 0 0 0	0 0 0 0 0	A	A	5

0 0 0 2 9 2 3

COMMENTS

Action	cd
A	A	6

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5/72

NATIONAL EMISSIONS DATA SYSTEM (NEDS)
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR PROGRAMS

AREA SOURCE
Input Form
Date _____

Name of Person Completing Form _____

FORSYTH

State	County	AQCR
37	067	036

Year of Record	EMISSION ESTIMATES (10^2 tons)				
	Particulate	SO_2	NO_x	HC	CO
73	00225				

SULFUR CONTENT (%)				ASH CONTENT (%)	
Anth Coal	Bitum Coal	Dist Oil	Resid Oil	Anth Coal	Bitum Coal
▲	▲	▲	▲	00	07

RESIDENTIAL FUEL					
Anth 10^1 tons	Bitumin 10^1 tons	Dist Oil 10^4 Gal.	Resid Oil 10^4 Gal.	Nat. Gas 10^7 ft^3	Wood 10^2 tons
00	00	00	00	00	00

Action		cd
A	A	1

COMMERCIAL AND INSTITUTIONAL FUEL					
Anth 10^1 tons	Bitumin 10^1 tons	Dist Oil 10^4 Gals	Resid Oil 10^5 Gals	Nat Gas 10^7 Ft^3	Wood 10^2 tons
00	00	30	00	30	30

INDUSTRIAL FUEL							
Anth Coal 10^1 tons	Bitum Coal 10^1 tons	Coke 10^1 tons	Dist Oil 10^4 Gals.	Resid Oil 10^4 Gals.	Nat. Gas 10^7 Ft^3	Wood 10^2 tons	Process Gas 10^7 ft^3
00	00	00	06	53	00	00	00

Action		cd
A	A	2

ON SITE INCINERATION				OPEN BURNING			GASOLINE FUEL				DIESEL FUEL					
Residential 10^1 tons	Industrial 10^2 tons	Comm. Inst. 10^2 tons	Residential 10^2 tons	Industrial 10^2 tons	Comm'l Instit. 10^2 tons	Light Vehicle 10^3 Gals.	Heavy Vehicle 10^3 Gals.	Off Hiway 10^3 Gals.	Heavy Vehicle 10^3 Gals.	Off Hiway 10^4 Gals.	Rail Locomotive 10^4 Gals.	County Population 10^3	Dens-ity Code
00	00	00	00	01	00	70	66	07	83	39	25	11	43	11	15	11	00	60	02	14	6	

Action		cd
A	A	3

AIRCRAFT			VESSELS				EVAPORATION		MEASURED VEHICLE MILES				
Military LTO CYC 10^3	Civil LTO CYC 10^3	Commercial LTO CYC 10^3	Anth. Coal 10^1 tons	Diesel Oil 10^4 Gals.	Resid. Oil 10^4 Gals.	Gasoline 10^3 Gals.	Solvent Purchased tons yr	Gasoline Marketed 10^5 Gals.	Limited Access Road 10^4 Miles	Rural Roads 10^4 Miles	Suburban Roads 10^4 Miles	Urban Roads 10^4 Miles	
00	05	02	65	00	05	12	00	00	02	63	00	02	97	00	00	15	20	0				

Action		cd
A	A	4

			FOREST FIRES		SLASH BURNING		FROST CONTROL			COAL REFUSE BURNING			
Dirt Roads Traveled 10^3 Miles	Dirt Air Strips LTO CYCLES	Construction Land Area 10^3 Acres	Rock Handling & Storing 10^3 tons	Area Acres	Quant. ton acre	Area Acres	Quant. tons acre	Orchard Heaters 10^2	Days Fired days yr	Structure Fires #/year	Size of Bank 10^4 yard^3	# year	
01	00	85	0	00	00	00	00	00	00	15	76	00	00	00	00	00	00				

Action		cd
A	A	5

0005691

COMMENTS

Action		cd
A	A	6

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9-72

NATIONAL EMISSIONS DATA SYSTEM (NEDS)
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR PROGRAMS

AREA SOURCE
Input Form
Date _____

GUILFORD

Name of Person Completing Form _____

State	County	AQCR
34	081	136

Year of Record	Particulate	SO_2	NO_x	HC	CO
73	00413				

SULFUR CONTENT (%): Anth Coal | Bitum Coal | Dist Oil | Resid Oil

ASH CONTENT (%): Anth Coal | Bitum Coal

RESIDENTIAL FUEL: Anth 10^1 tons | Bitumin 10^1 tons | Dist Oil 10^4 Gal. | Resid Oil 10^4 Gal. | Nat. Gas 10^7 ft.3 | Wood 10^2 tons | Action | cd

Anth Coal	Bitum Coal	Dist Oil	Resid Oil	Anth Coal	Bitum Coal	Anth 10^1 tons	Bitumin 10^1 tons	Dist Oil 10^4 Gal.	Resid Oil 10^4 Gal.	Nat. Gas 10^7 ft.3	Wood 10^2 tons	Action	cd
				00	07	00	00	039	00	00	00	A	1

COMMERCIAL AND INSTITUTIONAL FUEL: Anth 10^1 tons | Bitumin. 10^1 tons | Dist Oil 10^4 Gals | Resid Oil 10^4 Gals | Nat. Gas 10^7 ft.3 | Wood 10^2 tons

INDUSTRIAL FUEL: Anth Coal 10^1 tons | Bitum Coal 10^1 tons | Coke 10^1 tons | Dist Oil 10^4 Gals. | Resid Oil 10^4 Gals. | Nat. Gas 10^7 ft.3 | Wood 10^2 tons | Process Gas 10^7 ft.3 | Action | cd

Anth 10^1 tons	Bitumin. 10^1 tons	Dist Oil 10^4 Gals	Resid Oil 10^4 Gals	Nat. Gas 10^7 ft.3	Wood 10^2 tons	Anth Coal 10^1 tons	Bitum Coal 10^1 tons	Coke 10^1 tons	Dist Oil 10^4 Gals.	Resid Oil 10^4 Gals.	Nat. Gas 10^7 ft.3	Wood 10^2 tons	Process Gas 10^7 ft.3	Action	cd
00	00	00	42	00	11	92	99	00	00	00	00	23	00	A	2

ON SITE INCINERATION: Residential 10^1 tons | Industrial 10^2 tons | Comm. Inst. 10^2 tons

OPEN BURNING: Residential 10^2 tons | Industrial 10^2 tons | Comm'l Instit'l 10^2 tons

GASOLINE FUEL: Light Vehicle 10^1 Gals | Heavy Vehicle 10^3 Gals. | Off Hiway 10^3 Cal's.

DIESEL FUEL: Heavy Vehicle 10^3 Gals. | Off Hiway 10^4 Gals. | Rail Locomotive 10^4 Gals.

County Population 10^3 | Census Cat. | Action | cd

Residential 10^1 tons	Industrial 10^2 tons	Comm. Inst. 10^2 tons	Residential 10^2 tons	Industrial 10^2 tons	Comm'l Instit'l 10^2 tons	Light Vehicle 10^1 Gals	Heavy Vehicle 10^3 Gals.	Off Hiway 10^3 Cal's.	Heavy Vehicle 10^3 Gals.	Off Hiway 10^4 Gals.	Rail Locomotive 10^4 Gals.	County Population 10^3	Census Cat.	Action	cd
00	00	00	00	01	00	05	16	91	27	98	05	20	91	A	3

AIRCRAFT: Military LTO CYC 10^3 | Civil LTO CYC 10^3 | Commercial LTO CYC 10^3

VESSELS: Anth. Coal 10^3 tons | Diesel Oil 10^4 Gals. | Resid Oil 10^4 Gals. | Gasoline 10^3 Gals.

EVAPORATION: Solvent Purchased tons/yr | Gasoline Marketed 10^5 Gals.

MEASURED VEHICLE MILES: Limited Access Road 10^4 Miles | Rural Roads 10^4 Miles | Suburban Roads 10^4 Miles | Urban Roads 10^4 Miles

Military LTO CYC 10^3	Civil LTO CYC 10^3	Commercial LTO CYC 10^3	Anth. Coal 10^3 tons	Diesel Oil 10^4 Gals.	Resid Oil 10^4 Gals.	Gasoline 10^3 Gals.	Solvent Purchased tons/yr	Gasoline Marketed 10^5 Gals.	Limited Access Road 10^4 Miles	Rural Roads 10^4 Miles	Suburban Roads 10^4 Miles	Urban Roads 10^4 Miles	Action	cd
00	16	05	67	20	17	04	00	00	04	92	00	04	A	4

Dirt Roads Traveled 10^3 Miles | Dirt Air Strips LTO CYCLES | Construction Land Area 10^3 Acres | Rock Handling & Storing 10^3 tons

FOREST FIRES: Area Acres | Quant. ton/acre

SLASH BURNING: Area Acres | Quant. tons/acre

FROST CONTROL: Orchard Heaters 10^2 | Days Fired days/yr

Structure Fires #/year

COAL REFUSE BURNING: Size of Bank 10^3 yard^3 | # year

Dirt Roads Traveled 10^3 Miles	Dirt Air Strips LTO CYCLES	Construction Land Area 10^3 Acres	Rock Handling & Storing 10^3 tons	Forest Fires Area Acres	Forest Fires Quant. ton/acre	Slash Burning Area Acres	Slash Burning Quant. tons/acre	Frost Control Orchard Heaters 10^2	Frost Control Days Fired days/yr	Structure Fires #/year	Coal Refuse Burning Size of Bank 10^3 yard^3	Coal Refuse Burning # year	Action	cd
00	00	00	02	00	00	00	00	00	00	14	12	000	A	5

0010767 010

COMMENTS

Action	cd
A	6

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CHAPTER IV

AREA SOURCE EMISSIONS ALLOCATION, APPORTIONMENT, AND ASSIGNMENT

The following paragraphs discuss the methodology for allocation, apportionment, and assignment of county-wide emissions to the appropriate AQDM grid system for each county. Figures 1 through 3 show the grids. We have used the term "allocate" to indicate distribution of total county-wide quantities to subcounty areas; apportionment is the distribution of county-wide or subcounty quantities to the AQDM grid system; and assignment places a discreet area source, e.g., aircraft operations, into a particular grid or grids.

1. RESIDENTIAL FUEL USAGE

The total residential fuel use by fuel type was taken from the totals given in Tables 3 through 5; the allocation of these totals to subcensus tracts was based on the procedures given in Reference 10. A computer program was built to calculate emissions by tract. Inputs to the program included 1970 census data, updated to 1973, for dwelling units and population, fuel type distribution and dwelling size distribution, emission factors, and heating degree days. These theoretical emissions by tract were calibrated to agree with the totals from the fuel survey and the program was then rerun to allocate the total county emissions to tract adjusted by calibration factors. Calibration factors, i.e., the ratio between total county-wide theoretical emissions by type and survey emissions by type, are listed below:

County	Coal	Oil	Gas
Mecklenburg	0.828	1.128	0.952
Forsyth	0.410	0.757	0.417
Guilford	1.072	1.326	1.010

Next, emissions by census tract were apportioned to the AQDM grid system. (This process involves area integration by counting small squares on a clear map overlay.) Specifically, the number of area units of each

FIGURE 1

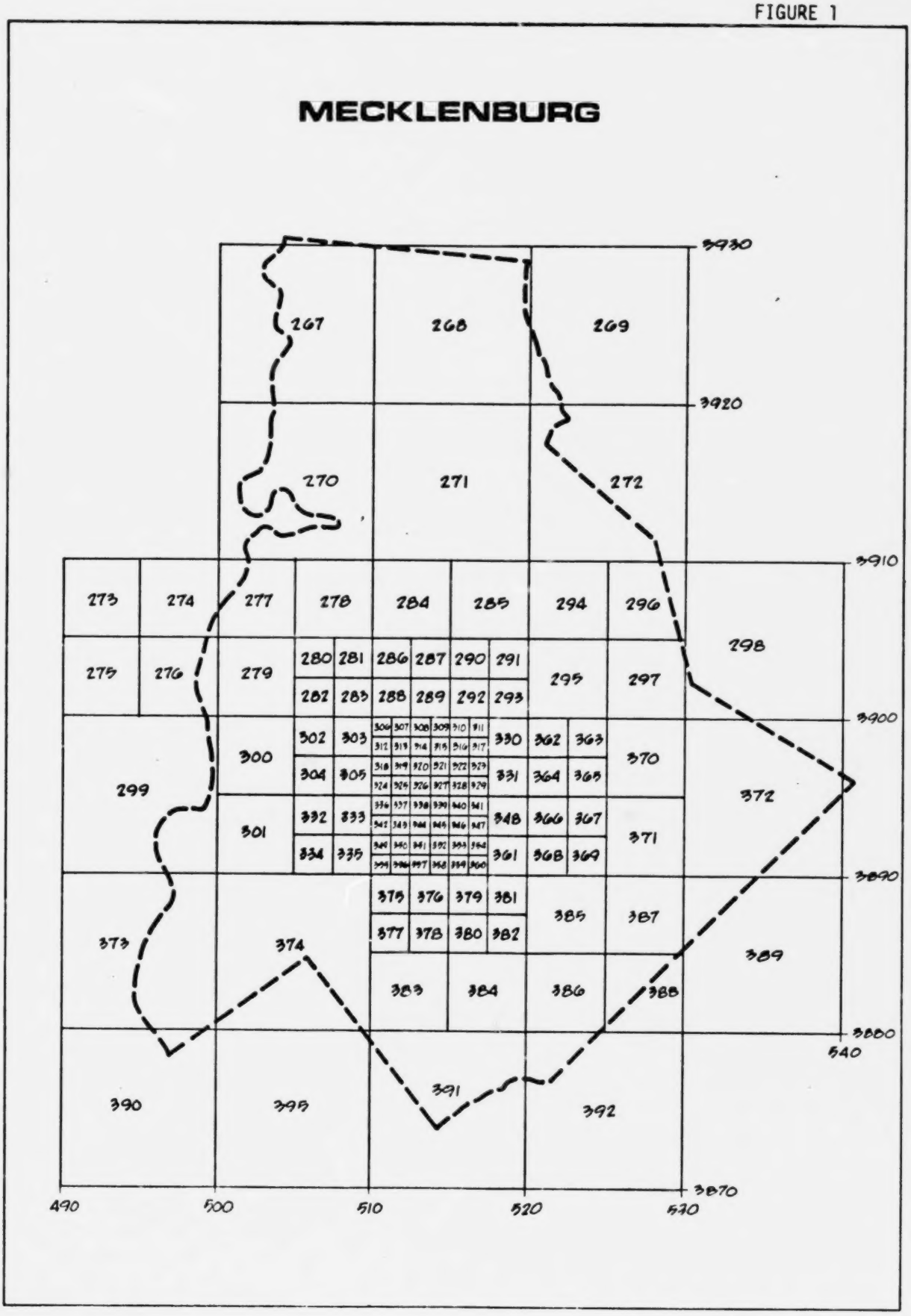
MECKLENBURG
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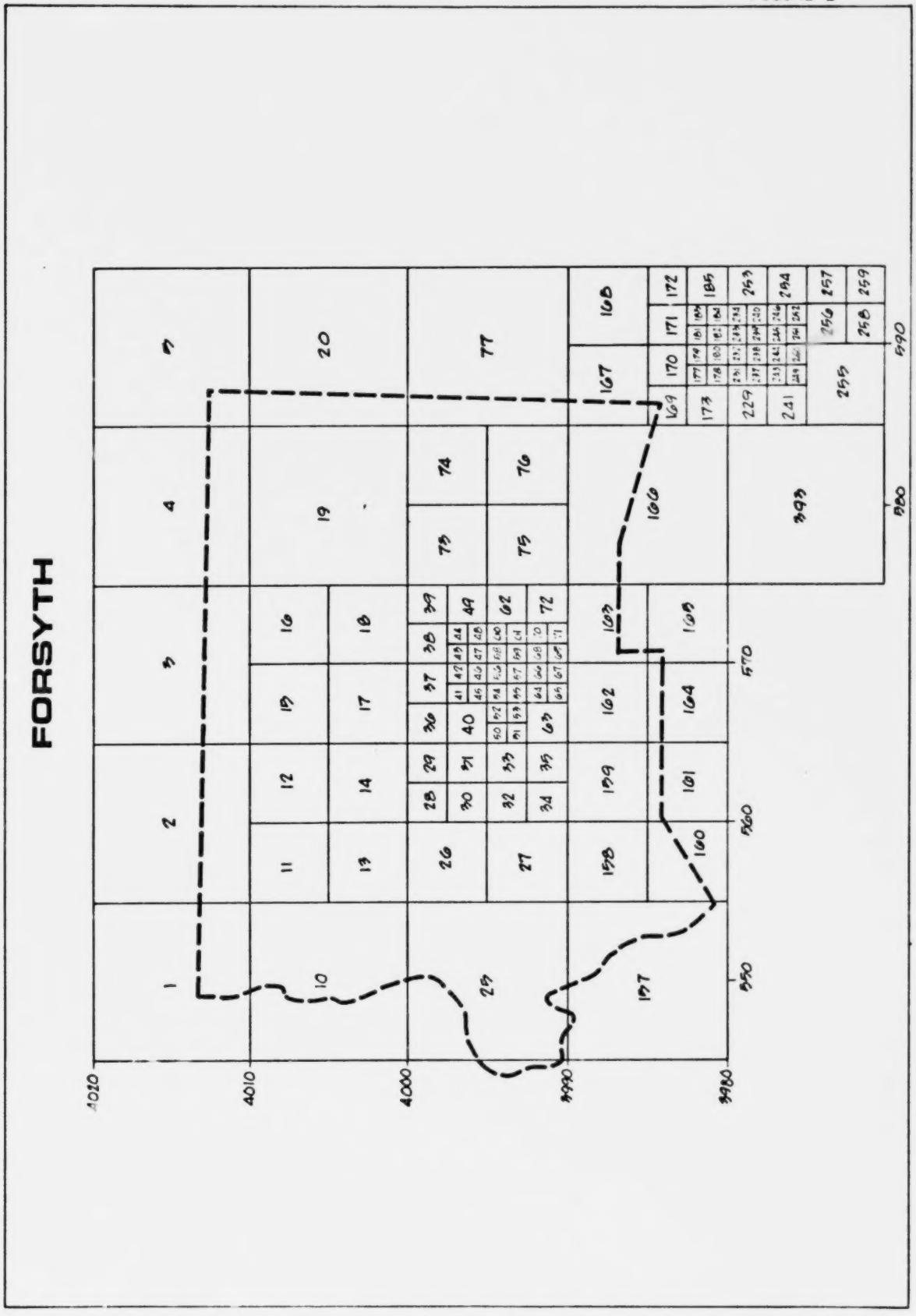
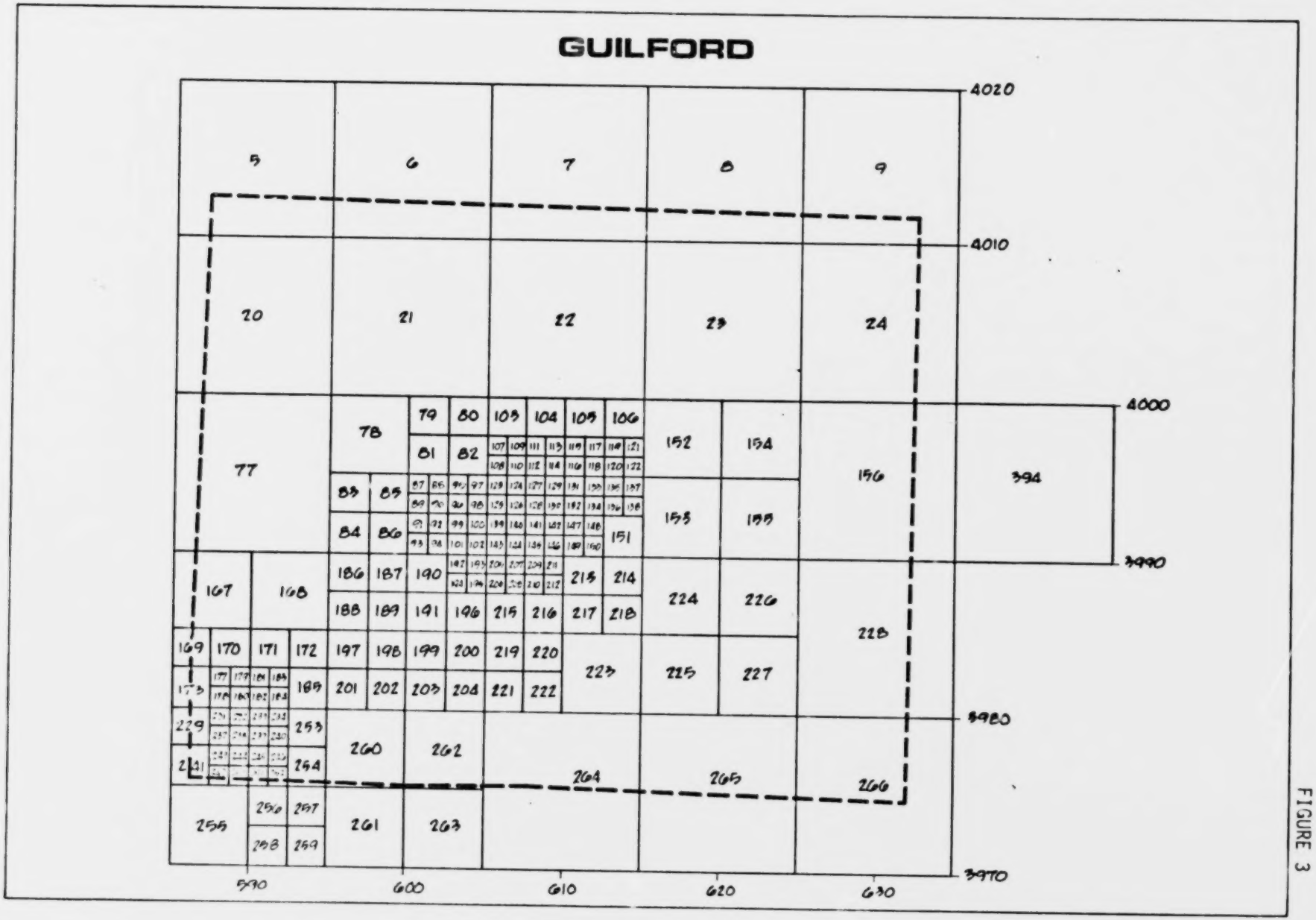
FIGURE 2

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6000
6100
6200
6300
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FIGURE 3

census tract residing within the confines of each AQDM grid square were determined by hand so that the census tract emissions could be apportioned to the grid system on an area percentage basis. The numerical calculations involved in this allocation were performed by the computer program so that both emissions by census tract and by grid were reported. A users manual for the program is available.

2. COMMERCIAL/INSTITUTIONAL FUEL USAGE

Although the procedures applied to residential emissions above are also applicable to commercial/institutional emissions, the data available in North Carolina were insufficient for this detailed treatment. The fuel survey, however, is a sound basis for development of the total emissions from commercial/institutional facilities.

Apportionment of this source category was based on land planning maps provided by the local planning agencies. The scale and type of maps available varied from large scale maps with each establishment specifically located to a general, small-scale land use map delineating commercial and institutional areas.

In Forsyth County, apportionment was made by the ratio of the number of establishments in each grid to the total number of establishments in the county. In the other two counties, area integration was used.

3. AREA SOURCE INDUSTRIAL FUEL USAGE

Apportionment of this source category was based on the same procedure as was commercial and institutional fuel usage. Apportionment factors for Mecklenburg County were provided by the local agency.

4. INTERNAL FUEL COMBUSTION STATIONARY SOURCES

There were no emissions in this source category.

5. SOLID WASTE DISPOSAL AND INCINERATION

Emissions from open burning were apportioned in accordance with the population in Mecklenburg County. In Forsyth and Builford Counties apportionment was by area to grid areas greater than 6.25 and 1.56 km^2, respectively.

In Mecklenburg County, emissions from incineration were assigned directly to a grid square by street address of the operating establishment from information provided by the local agency. This procedure was not possible in the other two counties. In these counties, incinerator emissions were apportioned equally among the 1.56 km^2 grids reflecting the "grocery store type incinerators" located in the high population, easy access areas.

6. OFF-ROAD VEHICLES

Farm tractor emissions were apportioned in accordance with the agricultural apportioning factor. These were arrived at subjectively using USGS maps and observed concentration of agricultural activity in each county. The grid square, which was considered to have the greatest activity, was assigned an arbitrary factor of 100. All other grids were then assigned a value from 0 to 100 in accordance with their relative agricultural activity.

Small gasoline engines were apportioned in accordance with population.

Emissions from diesel railroad locomotives were apportioned to grid squares in accordance with the number of train miles in each square. Railroad yard operations were assigned to squares where the switch yards are located, two in Guilford and one each in the other two counties.

Diesel construction equipment and miscellaneous diesel engines were apportioned uniformly by area.

7. ROAD VEHICLES

Emissions from this source category were apportioned to AQDM grids by two methods.

(1) Apportionment by highway location. For interstate and primary highways, the distribution of VMT by class was calculated from the data in Table 10. Using the emission factors given earlier for the three vehicle classes, an average emission factor was determined for interstate and primary highways for each county. These data are summarized in Table 20.

Within each grid square and for each major road (ADT >14,000), total emissions for the square were determined as the sum of the products of mean emission factors, road specific ADT, and length of road within the

TABLE 20

DATA FOR APPORTIONING BY LOCATION

County	VMT by Vehicle Class (%)			Mean EF[1] (gm/mi)
	LDVMT	HDGVMT	HDDVMT	
Mecklenburg	85	8	7	0.608
Forsyth	84	8	8	0.614
Guilford	82	10	8	0.620

(1) Calculated, as below, for Mecklenburg, for instance:

$$\text{Mean EF} = 0.85 \times 0.54 + 0.08 \times 0.85 + 0.07 \left| \frac{13 \times 454}{1000 \times 5.1} \right| = 0.608 \text{ g/mile}$$

grid. This procedure accounted for 48% of road vehicle emissions in Mecklenburg County, 43% in Forsyth County, and 44% in Guilford County.

(2) Apportionment by population. All emissions not apportioned by location were assumed to be directly proportional to the population and were apportioned by the population apportionment factors. The emissions so considered were as follows:

Mecklenburg	677.6 tons/year
Forsyth	400.7 tons/year
Guilford	600.9 tons/year

8. AIRCRAFT AND AIRPORT OPERATIONS

There were seven airports that had significant emissions. These were assigned as follows:

o Douglas Airport	26.35 tons/year to grid 304
o Willgrove	0.11 tons/year to grid 370
o Smith Reynolds	3.55 tons/year to grids 37 & 38
o Greensboro-High Point	16.04 tons/year to grid 83
o Air Harbor	0.01 tons/year to grid 22
o May	0.01 tons/year to grid 224
o Causey	0.02 tons/year to grid 265

9. VESSELS

There were insignificant emissions in this source category.

10. STRUCTURAL FIRES

Emissions from this source category were apportioned in accordance with population factors.

11. AGRICULTURAL BURNING

There were no emissions in this source category.

12. UNPAVED ROAD OPERATIONS

The North Carolina Department of Transportation and Highway Safety provided the Department of Natural and Economic Resources with 1970 county maps showing unpaved road locations with mileages and including link traffic counts taken in a 1970 state survey of unpaved roads. Also provided for the three counties were maps for 1973 showing most of the unpaved road revisions which occurred between 1970 and 1973, which were used to update the more extensive 1970 data.

The major cities within the three counties, through the street maintenance departments, also provided maps and data relating, where applicable, to municipally maintained unpaved roads.

Emissions from this source category were then apportioned to individual AQDM grids by the Department of Natural Economic Resources in accordance with the updated 1973 VMT on unpaved roads within each grid square.

13. UNPAVED AIRSTRIP OPERATIONS

The one source of emissions from this source category is assigned to grid number 370, the location of Willgrove Airport.

14. TILLING OPERATIONS

This source category was apportioned by the same method used for farm tractor apportionment.

15. CONSTRUCTION OPERATIONS

Residential construction emissions and 40% of the non-residential building construction emissions were assigned uniformly within the 6.25 km^2 and 1.56 km^2 grid squares.

In each county, there was one major shopping center complex built in 1973. Sixty percent of the non-residential building construction emissions were assigned to the grid squares in which these developments took place: Mecklenburg grid -- 366; Forsyth grid -- 35; and Guilford grid -- 193.

Non-building construction emissions were assigned to grids in which major highway construction took place in 1973. The parameter used for assignment was the product of highway length and months under construction. Table 21 lists the highway segments and grid assignments.

TABLE 21

NON-BUILDING CONSTRUCTION APPORTIONMENT

County	Highway Segment			Factor	%	Apportionment		
	No.	Length (miles)	Time (mos.)			%	Grid	Emissions (tons/year)
Mecklenburg	1	3.0	5	15.0	100.0	100.0	268	110.30
Forsyth	1	11.0	12	132.0	100.0	100.0	25	36.00
Guilford	1	4.5	12	54.0	18.3	6.1	200	4.80
						6.1	219	4.80
						6.1	215	4.80
	2	4.3	12	51.6	17.5	4.4	77	3.47
						13.1	168	10.32
	3	12.3	12	147.6	50.1	2.5	151	1.97
						12.6	153	9.93
						12.6	155	9.93
						17.6	156	13.87
						2.5	213	1.97
						2.5	214	1.97
	4	7.6	5	38.0	12.9	11.6	20	9.14
						1.3	77	1.02
	5	0.8	4	3.2	1.1	1.1	22	0.87
				TOTAL	99.9	100.1		78.86

16. FOREST MANAGEMENT BURNING

There were no emissions in this source category.

17. PAVED ROADS

Apportionment of this source category was in accordance with the distribution of VMT.

18. WILD FOREST FIRES

The locations of the 15 wild forest fires were known. The emissions resulting from each were assigned to the grid square in which they occurred.

19. AREA SOURCE PROCESS LOSSES

Apportionment of this source category used the same method as that for industrial fuel usage.

20. GRID TOTALS

Figure 4 (reduced) is an example of the forms used by Engineering-Science in compiling the grid totals from the several area source categories. Completed forms have been forwarded to the Department of Natural and Economic Resources.

ALLOCATION WORK SHEET

POLLUTANT

COUNTY _____

ENGINEERING - SCIENCE, INC

| GRID NO. | COORDINATES | | AREA | SOURCE WEIGHT | TOTAL EMISSIONS | AREA EMISSION FACTOR | VMT EMISSION FACTOR | AVG. SPEED FACTOR | EMISSION DENSITY | | |

CHAPTER V

COUNTY-WIDE AREA SOURCE EMISSION PROJECTIONS

The following paragraphs discuss the methodology for projecting the 1973 county-wide emissions to the planning years 1975, 1980, and 1985 and give the results of the projection calculations.

1. RESIDENTIAL FUEL USAGE

The projections in this source category are predicated upon increasing population and a changing split in the type of residential heating fuel used.

Estimations of population growth were provided by local planning agencies:

- Charlotte-Metropolitan Planning Commission
- Forsyth County Planning Department
- Guilford County Planning Department

The projected populations on a county-wide basis are shown in Table 22.

TABLE 22

BASELINE YEAR AND PROJECTED POPULATION

	1973	1975	1980	1985
Mecklenburg County	378434	401066	451189	551739
Forsyth County	222276	227000	239000	252000
Guilford County	302444	305449	325727	347106

Growth factors based on population are given in Table 23.

TABLE 23

BASELINE YEAR AND POPULATION GROWTH FACTORS

	1973	1975	1980	1985
Mecklenburg County	1.00	1.06	1.19	1.46
Forsyth County	1.00	1.02	1.08	1.13
Guilford County	1.00	1.01	1.08	1.15

Based on the historical decrease in coal as a residential heating fuel, coal usage from 1970 (the year of the last census for which fuel usage data was available) to 1985 was estimated to decrease by two-thirds[1] (a factor of 0.467 from 1973 to 1985). The current policy for no additional natural gas connections was expected to continue. Based on an opinion expressed by the planning staff of Duke Power, it was assumed that 50% of the coal conversions and new dwellings will use oil for heating and that 50% will use electricity. The use of wood for residential heating is expected to increase according to the population factor given in Table 23. No forecast change in dwelling size distribution was available; this parameter and the resulting heating efficiency were assumed to be constant in residential fuel use projections. However, the trend seems to be toward more multi-family dwellings and increased heating efficiency. Errors in the emission predictions caused by ignoring this trend are conservative, i.e., predicted emissions would tend to be larger than actual emissions.

Table 24 summarizes the projected emissions from residential fuel usage by fuel type for each of the counties.

The values for emissions from burning of coal, natural gas, LPG, and wood are derived directly from the above assumptions. The value for distillate oil was calculated in the following manner using the Mecklenburg 1985 projection as an example. With no change in fuel mix coal, gas, and LPG emissions would increase with the population factor:

Coal emissions: 31.6 x 1.46 = 46.1 tons/year
Gas emissions: 27.1 x 1.46 = 39.6 tons/year
LPG emissions: 3.0 x 1.46 = 4.4 tons/year

(1) Source: Reference 12.

TABLE 24

BASELINE YEAR AND PROJECTED EMISSIONS
FROM RESIDENTIAL FUEL USAGE (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County				
Bituminous Coal	31.6	28.8	21.7	14.7
Distillate Oil	129.8	144.2	175.4	240.2
Natural Gas	27.1	27.1	27.1	27.1
LPG	3.0	3.0	3.0	3.0
Wood	30.6	31.9	36.4	44.7
TOTAL	222.1	235.0	263.6	329.7
Forsyth County				
Bituminous Coal	22.1	20.1	15.2	10.3
Distillate Oil	117.2	120.6	130.2	138.2
Natural Gas	8.3	8.3	8.3	8.3
LPG	3.6	3.6	3.6	3.6
Wood	48.7	49.7	52.6	55.0
TOTAL	199.9	202.3	209.9	215.4
Guilford County				
Bituminous Coal	54.5	49.7	37.5	25.4
Distillate Oil	196.3	199.7	221.1	242.9
Natural Gas	25.6	25.6	25.6	25.6
LPG	3.7	3.7	3.7	3.7
Wood	93.6	94.5	101.0	107.6
TOTAL	373.7	373.2	388.9	405.2

The increment converted to oil is one half the difference between these population projected emissions and the actual emissions.

Coal emission: (46.1 - 14.7) x 1/2 = 15.7 tons/year

Gas emissions: (39.6 - 27.1) x 1/2 = 6.2 tons/year

LPG emissions: (4.4 - 3.0) x 1/2 = 0.7 tons/year

These emissions are converted to fuel burned by the appropriate emission factors (Section III-1).

Coal: $15.7 \times \frac{2000}{17} = 1847$ tons

Gas: $6.2 \times \frac{2000}{10} = 1240 \times 10^6$ ft^3

LPG: $0.7 \times \frac{2000}{1.85} = 757 \times 10^3$ gal

These fuels burned are then converted to distillate oil on a BTU equivalent basis.

Coal: $1847 \times \frac{2000 \times 13000}{140000 \times 1000} = 343 \times 10^3$ gal

Gas: $1240 \times \frac{10^6 \times 1050}{140000 \times 1000} = 9300 \times 10^3$ gal

LPG: $757 \times \frac{1000 \times 90500}{140000 \times 1000} = 489 \times 10^3$ gal

TOTAL 10132×10^3 gal

Emissions from this increment of distillate oil burned ,

$$\frac{10132 \times 10}{2000} = 50.7 \text{ tons/year,}$$

are added to the emissions expected from normal growth,

129.8 x 1.46 = 189.5 tons/year,

to give total distillate oil emissions of 240.2 tons/year.

2. COMMERCIAL/INSTITUTIONAL FUEL USAGE

Growth factors for this source category were provided by the planning agencies listed in the preceeding section and these have been confirmed by the Department of Natural and Economic Resources as the best available planning

information. Growth factors are listed in Table 25 and projected emissions in Table 26.

TABLE 25

BASELINE YEAR AND COMMERICAL/INSTITUTIONAL GROWTH FACTORS

	1973	1975	1980	1985
Mecklenburg County	1.000	1.035	1.127	1.228
Forsyth County	1.000	1.146	1.293	1.369
Guilford County	1.000	1.053	1.186	1.320

TABLE 26

BASELINE YEAR AND PROJECTED EMISSIONS FROM COMMERCIAL/INSTITUTIONAL FUEL USAGE (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	265.7	275.0	299.4	326.3
Forsyth County	37.6	43.1	48.6	51.5
Guilford County	35.0	36.9	41.5	46.2

3. AREA SOURCE INDUSTRIAL FUEL USAGE

Growth factors for this source category were provided by the planning agencies listed in Section 1 and these have been confirmed by the Department of Natural and Economic Resources as the best available planning information. Growth factors are listed in Table 27 and projected emissions in Table 28.

TABLE 27

BASELINE YEAR AND INDUSTRIAL GROWTH FACTORS

	1973	1975	1980	1985
Mecklenburg County	1.000	1.011	1.079	1.286
Forsyth County	1.000	1.009	1.018	1.043
Guilford County	1.000	1.031	1.109	1.188

TABLE 28

BASELINE YEAR AND PROJECTED EMISSIONS FROM
AREA SOURCE INDUSTRIAL FUEL USAGE (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	318.1	321.6	343.2	409.1
Forsyth County	56.6	57.1	57.6	59.0
Guilford County	77.6	80.0	86.1	92.2

4. INTERNAL FUEL COMBUSTION STATIONARY SOURCES

There were no sources in this category in the baseline year area source emission inventory. Transcontinental Gas Pipeline Corporation has no plans for constructing a compressor station within any of the three counties.

5. SOLID WASTE DISPOSAL AND INCINERATION

Mecklenburg County. The stringent control of open burning exercised by the local agency is expected to continue. The 4.5 tons of particulate matter emitted from permissible agricultural waste burning is projected to decrease in accordance with the agricultural activity decay factors given in Table 29, and the emissions resulting from the authorized burning of diseased trees is projected to remain constant. Emissions from fire training and automobile fires are projected to grow in accordance with the population factors in Table 23.

The incinerators involved in Mecklenburg County as well as in the other counties are those associated with small retail outlets and institutions. The emissions are projected to grow in accordance with the commercial/institutional growth factors given in Table 25.

Emissions for these source categories for Mecklenburg County are summarized in Table 30.

Forsyth County. Emissions from land clearing, brush clearing, and grass, wood, and brush fires are projected to decrease in accordance with the agricultural activity decay factor in Table 29. Emissions from open burning of garbage is projected to be zero in 1975 and thereafter. Emissions from open burning of leaves and miscellaneous and from fire training and automobile fires is projected to increase in accordance with population factors in Table 23.

Emissions from incinerators are projected to increase in accordance with the commercial/institutional growth factors given in Table 25. Projected emissions are summarized in Table 30.

Guilford County. The same procedures were used in Guilford County as were used in Forsyth County for projecting emissions from this source category. Projected emissions are summarized in Table 30.

6. OFF-ROAD VEHICLES

The baseline year emission inventory considered six classes of off-road vehicles. Two were combined into one class leaving the following five:

- o Gasoline farm tractors
- o Small gasoline engines
- o Diesel farm tractors
- o Diesel construction equipment
- o Diesel railroad operations

Emissions from farm tractors, gasoline and diesel combined, are projected at a negative growth of 11.73% for each 5.61% increase in population as determined in Section III-14: TILLING OPERATIONS. This results in the decay factors given in Table 29 and emissions given in Table 31.

TABLE 29

BASELINE YEAR AND AGRICULTURAL ACTIVITY DECAY FACTORS

	1973	1975	1980	1985
Mecklenburg County	1.00	0.88	0.60	0.04
Forsyth County	1.00	0.96	0.83	0.73
Guilford County	1.00	0.98	0.83	0.69

TABLE 30

BASELINE YEAR AND PROJECTED EMISSIONS
FROM SOLID WASTE DISPOSAL (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County				
Agricultural Disposal	4.5	4.0	2.7	0.2
Diseased Trees	18.4	18.4	18.4	18.4
Fire Training and Automobiles	9.0	9.5	10.7	13.1
Total Open Burning	31.9	31.9	31.8	31.7
Incineration	22.0	22.8	24.8	27.0
Forsyth County				
Agricultural Disposal	42.6	41.0	35.4	31.2
Garbage	13.1	0	0	0
Leaves and Miscellaneous	2.8	2.9	3.0	3.2
Fire Training and Automobiles	5.3	5.4	5.7	6.0
Total Open Burning	63.8	49.3	44.1	40.4
Incineration	9.0	10.3	11.6	12.3
Guilford County				
Agricultural Disposal	67.9	66.5	56.4	46.9
Garbage	20.8	0	0	0
Leaves and Miscellaneous	3.8	3.8	4.1	4.4
Fire Training and Automobiles	7.2	7.3	7.8	8.3
Total Open Burning	99.7	77.6	68.3	59.6
Incineration	12.2	12.8	14.5	16.1

TABLE 31

BASELINE YEAR AND PROJECTED EMISSIONS
FROM FARM TRACTORS (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	3.9	3.4	2.3	0.2
Forsyth County	27.2	26.1	22.6	19.9
Guilford County	59.9	58.7	49.7	41.3

Emissions from small gasoline engines are projected to increase with the population factors given in Table 23 and are summarized in Table 32.

TABLE 32

BASELINE YEAR AND PROJECTED EMISSIONS
FROM SMALL GASOLINE ENGINES (TON/YEAR)

	1973	1975	1980	1985
Mecklenburg County	26.3	27.9	31.3	38.4
Forsyth County	15.5	15.8	16.7	17.5
Guilford County	21.0	21.2	22.7	24.2

Emissions from diesel construction equipment operation, in order to be consistent with the inventory methodology, should be based upon projected non-building construction employment. These projections are not available, nor are the contract construction employment data used for estimating the emissions from construction activity. For this reason projections of contract construction total earnings for the appropriate SMSA from the Department of Commerce, OBERS publication is used for this source category. The earnings values are given in Table 33 and the projection factors in Table 34.

TABLE 33

CONTRACT CONSTRUCTION ACTUAL EARNINGS (1970-1975)
AND PROJECTIONS (1980-1985)
(in thousands of dollars)

	1970	1975	1980	1985
Mecklenburg County	124646	155000	183800	220500
Forsyth County[1]	120423	149400	180800	221200
Guildford County[1]				

[1]Forsyth and Guilford Counties are in the same SMSA.

TABLE 34

BASELINE YEAR AND CONSTRUCTION EARNING GROWTH FACTORS

	1973[1]	1975	1980	1985
Mecklenburg County	1.00	1.08	1.29	1.54
Forsyth County	1.00	1.08	1.31	1.61
Guilford County				

[1]The 1973 value is obtained from linear interpolation between the 1970 and 1975 values given in Table 35.

Using these projections, unmodified, to determine projected emissions from diesel equipment appears to result in excessive growth. For instance, a comparison of the resulting 1985 factors with those given earlier is shown in Table 35.

TABLE 35

COMPARISON OF 1985 FACTORS

	Earnings Table 34	Population Table 23	C&I Table 25[1]	Industrial Table 27[1]
Mecklenburg County	1.54	1.46	1.23	1.29
Forsyth County	1.61	1.13	1.37	1.04
Guilford County	1.61	1.15	1.32	1.19

[1]Figures rounded.

A better estimate, albeit difficult to objectively justify, might be the average of those four types of factors; at least this method would consider growth in the major divisions of construction, if it is assumed that highway construction parallels other construction activity. Consequently, in Table 36 are given the average growth factors which are used for projecting this source category and Table 37, the resulting projected emissions.

TABLE 36

BASELINE YEAR AND CONSTRUCTION EQUIPMENT GROWTH FACTORS

	1973	1975	1980	1985
Mecklenburg County	1.00	1.05	1.17	1.38
Forsyth County	1.00	1.06	1.18	1.29
Guilford County	1.00	1.04	1.17	1.32

TABLE 37

BASELINE YEAR AND PROJECTED EMISSIONS
FROM DIESEL CONSTRUCTION EQUIPMENT (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	60.8	63.8	71.1	83.9
Forsyth County	6.6	7.0	7.8	8.5
Guilford County	10.7	11.1	12.5	14.1

Data on growth in intercity railroad freight traffic were provided by the Economics and Finance Department of the Association of American Railroads. The annual average growth rate for such traffic, for the period 1954 to 1974, has been 2.2% for railroad ton miles. This is to be compared with a 3.5% growth rate for all modes of intercity freight traffic. During this period the railroad share of traffic decreased from 49.6% in 1954 to 38.6% in 1974. This decreasing trend in the share of the market is expected to stop with the accelerated use of coal as fuel and the use of rail for its transport. Consequently, in projecting emissions for both road haul and yard operations, we have used a compound growth factor of 1.035.

The results are given in Tables 38 and 39.

TABLE 38

BASELINE YEAR AND PROJECTED EMISSIONS
FROM RAILROAD ENGINES (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	27.6	29.6	35.1	41.7
Forsyth County	6.7	7.2	8.5	10.1
Guilford County	35.5	38.0	45.2	53.6

TABLE 39

BASELINE YEAR AND PROJECTED EMISSIONS
FROM RAILROAD YARD OPERATIONS (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	3.5	3.7	4.5	5.3
Forsyth County	0.8	0.9	1.0	1.2
Guilford County	4.4	4.7	5.6	6.6

7. ROAD VEHICLES

The Department of Transportation and Highway Safety provided projected travel statistics as summarized in Table 40.

TABLE 40

PROJECTED DAILY VEHICLE MILES TRAVELED
IN URBANIZED AREAS

	1972	1980	1990
Charlotte	4,600,000	6,950,000	9,585,580
Winston-Salem	2,790,000	4,100,000	5,736,720
Greensboro	2,510,000	3,600,000	5,033,940
High Point	1,220,000	1,610,000	2,117,477

Assuming no change in road vehicle emission factors for particulates and no change in vehicular mix projection, projection factors were determined from the travel estimates and are given in Table 41. Linear interpollution was used to calculate the 1973, 1975, and 1985 VMT, and Greensboro and High Point values were added for Guilford County.

TABLE 41

BASELINE YEAR AND ROAD VEHICLE GROWTH FACTORS

	1973	1975	1980	1985
Mecklenburg County	1.00	1.12	1.42	1.69
Forsyth County	1.00	1.11	1.39	1.66
Guilford County	1.00	1.09	1.33	1.58

The projected emissions are given in Table 42.

TABLE 42

BASELINE YEAR AND PROJECTED EMISSIONS FROM ROAD VEHICLES (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	1302.7	1459.0	1849.8	2201.6
Forsyth County	703.2	780.6	977.4	1167.3
Guilford County	1073.4	1170.0	1427.6	1696.0

8. AIRCRAFT AND AIRPORT OPERATIONS

Projections of emissions for this source category are dependent upon three factors:

- o Increased operational activity at the airports,
- o Change in the mix of the various classes of aircraft,
- o More stringent control of aircraft emissions.

There are no known plans for further control regulations on aircraft, consequently, the emission factors used in the baseline year emission inventory are used in the projection.

Increased operations and changed mix information, which is available from FAA publication Terminal Area Forecasts 1976 - 1986, is summarized in Table 43.

In projecting emissions from the projected aircraft activity the following assumptions were made:

- o No jumbo jet operations are expected,
- o No growth in long-range jets is expected,
- o A 50% decrease in air carrier turbo-prop operations is expected by 1985,
- o The 2-engine/3-engine mix of medium-range jets will remain consistent,
- o The air taxi mix is constant,
- o No growth in military aircraft emissions,
- o The general aviation mix is constant,
- o The growth for activity at the small non-FAA airports is the same as single-engine piston general aviation growth at FAA airports.

Using these assumptions projected emissions for the source category were calculated and are summarized in Tables 44 through 46.

9. VESSELS

There were no baseline year emissions in this source category. Although the boat population is expected to increase, no significant change in the types of boats and boat engines operated in the area is anticipated by the North Carolina Department of Recreation and, consequently, no increase in particulate emissions is expected.

10. STRUCTURAL FIRES

Emissions from this source category, which are projected to increase with the population factors given in Table 23, are summarized in Table 47.

11. AGRICULTURAL BURNING

There were no baseline year emissions in this source category and none were projected since no major change in agricultural practice is anticipated.

TABLE 43

LTOs

1973 AND PROJECTED LTOs

Douglas Airport	1973	1975[1]	1980[1]	1985[1]
Air Carrier	31838	33613	39700	45000
Air Taxi	3144	3000	3400	5200
Other	61188	70060	94900	145600
TOTAL	96170	106673	138000	195800

Smith-Reynolds Airport	1973	1975	1980	1985
Air Carrier	5114	4705	5300	6300
Air Taxi	8	336	500	500
Other	26987	45996	69100	98900
TOTAL	32109	51037	74900	105700

Greensboro-High Point Airport	1973	1975	1980	1985
Air Carrier	16471	16490	19300	22000
Air Taxi	569	856	1000	1400
Other	54816	64939	88000	129300
TOTAL	71856	82285	108300	152700

[1] Source: Terminal Area Forecasts 1976-1986, Department of Transportation, FAA. The 1975, 1980, and 1985 values are linearly interpolated from the 1976, 1981, and 1986 given values.

TABLE 44

PROJECTED AIRCRAFT EMISSIONS, MECKLENBURG COUNTY

(LBS/YEAR)

	1973	1975	1980	1985
DOUGLAS AIRPORT				
Air Carrier				
Jumbo Jet	0	0	0	0
Long-Range Jet	3146	3146	3146	3146
Medium-Range Jet	24908	26718	33256	39068
Turbo-Prop	8800	8800	6600	4400
Air Taxi				
Piston Transport	840	840	908	1389
Turbo-Prop	800	800	865	1323
Military				
Transport	7425	7425	7425	7425
Piston	70	70	70	70
Jet	16	16	16	16
General Aviation				
Business Jet	1287	1482	2027	3140
Turbo-Prop	460	529	724	1122
Piston Transport	3304	3804	5204	8060
Helicopter	737	849	1161	1798
Piston	915	1053	1441	2232
DOUGLAS AIRPORT TOTAL	52708	55532	62843	73189
WILLGROVE AIRPORT	216	249	340	527
BRADFORD AIRPORT	5	6	8	12
DELTA AIRPORT	1	1	2	2
MECKLENBURG COUNTY TOTAL	52930	55788	63193	73730

TABLE 45

PROJECTED AIRCRAFT EMISSIONS, FORSYTH COUNTY

(LBS/YEAR)

	1973	1975	1980	1985
SMITH-REYNOLDS AIRPORT				
Air Carrier				
Jumbo Jet	0	0	0	0
Long-Range Jet	0	0	0	0
Medium-Range Jet	1304	1200	2292	3797
Turbo-Prop	7986	7347	5511	3674
Air Taxi				
Piston Transport	3	126	188	188
Turbo-Prop	2	84	125	125
Military				
Transport	0	0	0	0
Piston	7	7	7	7
Jet	0	0	0	0
Turbo-Prop	1069	1069	1069	1069
Helicopter	55	55	55	55
General Aviation				
Business Jet	583	1001	1509	2165
Turbo-Prop	1600	2748	4143	5942
Piston Transport	1176	2020	3045	4367
Helicopter	63	108	163	234
Piston	371	637	961	1378
SMITH-REYNOLDS AIRPORT TOTAL	14219	16402	19068	23001
FORSYTH COUNTY TOTAL	14219	16402	19068	23001

TABLE 46

PROJECTED AIRCRAFT EMISSIONS, GUILFORD COUNTY

(LBS/YEAR)

	1973	1975	1980	1985
Greensboro-High Point Airport				
Air Carrier				
Jumbo Jet	0	0	0	0
Long-Range Jet	0	0	0	0
Medium-Range Jet	12838	12838	16727	20513
Turbo-Prop	8745	8745	6559	4373
Air Taxi				
Piston Transport	210	316	369	517
Turbo-Prop	130	196	228	320
Military				
Transport	3960	3960	3960	3960
Piston	112	112	112	112
Jet	16	16	16	16
General Aviation				
Business Jet	1166	1388	1894	2800
Turbo-Prop	420	500	682	1008
Piston Transport	2996	3566	4866	7193
Helicopter	663	789	1077	1592
Piston	830	988	1348	1993
GREENSBORO-HIGH POINT AIRPORT TOTAL	32086	33414	37838	44397
AIRHARBOR AIRPORT	24	29	39	58
MAY AIRPORT	12	14	19	29
CAUSEY AIRPORT	30	36	49	72
MID ATLANTIC AIRPORT	5	6	8	12
GUILFORD COUNTY TOTAL	32157	33499	37953	44568

TABLE 47

BASELINE YEAR AND PROJECTED EMISSIONS
FROM STRUCTURAL FIRES (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	17.7	18.8	21.1	25.8
Forsyth County	13.8	14.1	14.9	15.6
Guilford County	21.6	21.8	23.3	24.8

12. UNPAVED ROAD OPERATIONS

Historical data for unpaved road mileage were provided by the North Carolina Department of Transportation and Highway Safety as shown in Table 48.

TABLE 48

UNPAVED ROAD MILEAGE

	1955	1960	1965	1969	1970	1971	1972	1973
Mecklenburg County	245.6	182.5	175.0	157.7	152.8	149.2	146.2	144.3
Forsyth County	433.2	390.4	350.0	295.8	276.3	269.8	249.3	239.9
Guilford County	758.6	707.4	637.7	546.6	517.8	496.0	475.9	453.8

These historical data show a steady decrease in unpaved road mileage as the secondary and urban road systems are improved. However, the Department could not provide information for 1975 and beyond except to indicate continual improvement of the system within spending and other limitations. During the four-year period from 1969 to 1973, compound negative growth for each of the counties was as follows:

- Mecklenburg County 0.978/year
- Forsyth County 0.949/year
- Guilford County 0.955/year

If this negative growth continues through the next decade, the resulting unpaved road mileage would be as shown in Table 49.

TABLE 49

PROJECTED UNPAVED ROAD MILEAGE

	1973	1975	1980	1985
Mecklenburg County	144.3	138.0	123.5	110.5
Forsyth County	239.9	216.1	166.3	128.0
Guilford County	453.8	413.9	328.8	261.2

No change is expected in the unpaved road ADT or other parameters entering into the equation for determining emissions from this source category; consequently,

the reductions in emissions, summarized in Table 50 are proportional to the negative growth in mileage.

TABLE 50

BASELINE YEAR AND PROJECTED EMISSIONS
FROM UNPAVED ROADS (TONS/YEAR)

	1973	1974	1980	1985
Mecklenburg County	7116.5	6805.8	6090.7	5449.6
Forsyth County	15665.0	14110.9	10859.1	8358.1
Guilford County	24580.8	22419.6	17810.0	14148.3

13. UNPAVED AIRSTRIP OPERATIONS

There was one airport, Willgrove Airport in Mecklenburg County, which emitted 12.5 tons/year. Projections for this source are in accordance with the growth in aviation activity and are proportional to the aircraft emissions given in Table 46, General Aviation, piston.

1973: 12.5 tons/year
1975: 14.4 tons/year
1980: 19.7 tons/year
1985: 30.5 tons/year

14. TILLING OPERATIONS

Emissions from this source category are projected to decrease in accordance with the decay factors given in Table 29. Emissions from this category are summarized below in Table 51.

TABLE 51

BASELINE YEAR AND PROJECTED EMISSIONS
FROM TILLING OPERATIONS (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	30.7	27.0	18.4	1.2
Forsyth County	65.7	63.1	54.5	48.0
Guilford County	156.0	152.9	129.5	107.6

15. CONSTRUCTION OPERATIONS

Projected emissions for this source category are in accordance with the growth factors given in Table 36 and are summarized in Table 52.

TABLE 52

BASELINE YEAR AND PROJECTED EMISSIONS FROM CONSTRUCTION ACTIVITY (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	146.2	153.5	171.1	201.8
Forsyth County	47.8	50.7	56.4	61.7
Guilford County	105.2	109.4	123.1	138.9

16. FOREST MANAGEMENT BURNING

There were no baseline year emissions in this source category and none are projected since no change in forest management practice is anticipated.

17. PAVED ROADS

Emissions from this source category are projected in accordance with the growth factors given in Table 41 and are summarized in Table 53.

TABLE 53

BASELINE YEAR AND PROJECTED EMISSIONS FROM PAVED ROADS (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	9413.3	10542.7	13366.9	15908.6
Forsyth County	7198.5	7990.5	10006.0	11949.5
Guilford County	10914.5	11879.0	14516.5	17245.0

18. WILD FOREST FIRES

There were emissions in 1973 in only one county: 2.0 tons in Guilford County. It is reasonable to believe that increased encroachment upon forest lands by commercial and residential development and improved fire fighting procedures will reduce the forest acreage subject to fire and reduce timber consumed by fire. Because of the minor contribution of this source category to total emissions and the lack of any rationale for projecting or allocating these contributions, future emissions for all counties are assumed to be zero.

19. AREA SOURCE PROCESS LOSSES

Emissions from this source category are projected to increase in accordance with the industrial growth factors given in Table 27 and are summarized in Table 54.

20. COUNTY SUMMARIES

Tables 55 through 57 summarize projected county-wide area source emissions.

TABLE 54

BASELINE YEAR AND PROJECTED

EMISSIONS FROM AREA SOURCE PROCESS LOSSES (TONS/YEAR)

	1973	1975	1980	1985
Mecklenburg County	60.0	60.7	64.7	77.2
Forsyth County	32.0	32.3	32.6	33.4
Guilford County	121.0	124.8	134.2	143.7

TABLE 55

PROJECTED AREA SOURCE EMISSIONS - MECKLENBURG COUNTY

(TONS/YEAR)

	1973	1975	1980	1985
Residential Fuel	222.1	235.0	263.6	329.7
Commercial/Institutional Fuel	265.7	275.0	299.4	326.3
Industrial Fuel	318.1	321.6	343.2	409.1
Internal Fuel Combustion	0	0	0	0
Open Burning	31.9	31.9	31.8	31.7
Incineration	22.0	22.8	24.8	27.0
Farm Tractors	3.9	3.4	2.3	0.2
Small Gasoline Engine	26.3	27.9	31.3	38.4
Diesel Construction	60.8	63.8	71.1	83.9
Railroad Engine	27.6	29 6	35.1	41.7
Railroad Yards	3.5	3.7	4.5	5.3
LDV	1072.6	1201.3	1523.1	1812.7
HDGV	104.2	116.7	148.0	176.1
HDDV	125.9	141.0	178.8	212.8
Aircraft	26.5	27.9	31.6	36.9
Vessels	0	0	0	0
Structural Fires	17.7	18.8	21.1	25.8
Agricultural Burning	0	0	0	0
Unpaved Roads	7116.5	6805.8	6090.7	5449.6
Unpaved Airstrips	12.5	14.4	19.7	30.5
Tilling	30.7	27.0	18.4	1.2
Construction	146.2	153.5	171.1	201.8
Forest Management	0	0	0	0
Paved Roads	9413.3	10542.7	13366.9	15908.6
Wild Forest Fires	0	0	0	0
Area Source Process Losses	60.0	60.7	64.7	77.2
TOTAL	19108.0	20124.5	22741.2	25226.5

TABLE 56

PROJECTED AREA SOURCE EMISSIONS - FORSYTH COUNTY

(TONS/YEAR)

	1973	1975	1980	1985
Residential Fuel	199.9	202.3	209.9	215.4
Commercial/Institutional Fuel	37.6	43.1	48.6	51.5
Industrial Fuel	56.6	57.1	57.6	59.0
Internal Fuel Combustion	0	0	0	0
Open Burning	63.8	49.3	44.1	40.4
Incineration	9.0	10.3	11.6	12.3
Farm Tractors	27.2	26.1	22.6	19.9
Small Gasoline Engine	15.5	15.8	16.7	17.5
Diesel Construction	6.6	7.0	7.8	8.5
Railroad Engines	6.7	7.2	8.5	10.1
Railroad Yards	0.8	0.9	1.0	1.2
LDV	567.2	629.6	788.4	941.6
HDGV	61.7	68.5	85.8	102.4
HDDV	74.3	82.5	103.3	123.3
Aircraft	7.1	8.2	9.5	11.5
Vessels	0	0	0	0
Structural Fires	13.8	14.1	14.9	15.6
Agricultural Burning	0	0	0	0
Unpaved Roads	15665.0	14110.9	10859.1	8358.1
Unpaved Airstrips	0	0	0	0
Tilling	65.7	63.1	54.5	48.0
Construction	47.8	50.7	56.4	61.7
Forest Management	0	0	0	0
Paved Roads	7198.5	7990.5	10006.0	11949.5
Wild Forest Fires	0	0	0	0
Area Source Process Losses	32.0	32.3	32.6	33.4
TOTAL	24156.8	23469.5	22438.9	22080.9

TABLE 57

PROJECTED AREA SOURCE EMISSIONS - GUILFORD COUNTY

(TONS/YEAR)

	1973	1975	1980	1985
Residential Fuel	373.7	373.2	388.9	405.2
Commercial/Institutional Fuel	35.0	36.9	41.5	46.2
Industrial Fuel	77.6	80.0	86.1	92.2
Internal Fuel Combustion	0	0	0	0
Open Burning	99.7	77.6	68.3	59.6
Incineration	12.2	12.8	14.5	16.1
Farm Tractors	59.9	58.7	49.7	41.3
Small Gasoline Engines	21.0	21.2	22.7	24.2
Diesel Construction	10.7	11.1	12.5	14.1
Railroad Engines	35.5	38.0	45.2	53.6
Railroad Yards	4.4	4.7	5.6	6.6
LDV	851.4	928.0	1132.4	1345.2
HDGV	100.7	109.8	133.9	159.1
HDDV	121.3	132.2	161.3	191.7
Aircraft	16.1	16.7	19.0	22.3
Vessels	0	0	0	0
Structural Fires	21.6	21.8	23.3	24.8
Agricultural Burning	0	0	0	0
Unpaved Roads	24580.8	22419.6	17810.0	14148.3
Unpaved Airstrips	0	0	0	0
Tilling	156.0	152.9	129.5	107.6
Construction	105.2	109.4	123.1	138.9
Forest Management	0	0	0	0
Paved Roads	10914.5	11879.0	14516.5	17245.0
Wild Forest Fires	2.0	0	0	0
Area Source Process Losses	121.0	124.8	134.2	143.7
TOTAL	37720.3	36608.4	34918.2	34285.7

CHAPTER VI

PROJECTED AREA SOURCE EMISSIONS ALLOCATION, APPORTIONMENT, AND ASSIGNMENT

The following paragraphs discuss the methodology for allocation, apportionment, and assignment of county-wide projected emissions to the appropriate AQDM grid system for each county.

1. RESIDENTIAL FUEL USAGE

Population growth by census tract was obtained from information provided by the several county planning agencies. In general, to determine such growth by tract required reduction of growth projections from larger areas by area integration. The assumptions concerning fuel type distribution and dwelling size distribution described in Section V-1 were applied to each census tract. With these assumptions and projected tract population, emissions for each tract were calculated and then apportioned to grid squares by the computer program described in Section IV-1.

A second run of the computer program calculated factors based on population alone for apportioning two other source categories, structural fires and miscellaneous gasoline engine emissions. For this run no change in fuel type distribution was assumed. The program output consequently calculated emissions for each grid square which reflected only population growth and could be used as factors for projecting emissions which depended upon population alone.

2. COMMERCIAL/INSTITUTIONAL FUEL USAGE

Apportionment of this source category was based on planning information provided by local planning agencies:

- Mecklenburg County 1995 general development plan.
- Forsyth County general development plan for 10-year increments to 2000.
- Guilford County commercial/institutional growth plan to 1985.

In each case areas of commercial/institutional growth indicated by the planning documents were determined and, by area integration, apportioned to

grid squares. The growth factors so determined for each grid were the bases for apportioning projected emissions.

3. AREA SOURCE INDUSTRIAL FUEL USAGE

Apportionment of projected emissions in this source category was based on information provided by the Department of National and Economic Resources concerning the location of growth in industrial point sources. For each county, point source growth in tons/year was listed for growth in place, for new unknown growth, and the grid location of the new unknown growth.

Projected industrial area source emissions were assumed to grow in the same proportion between in place growth and new growth as were point sources. These values are given in Table 58. Apportionment of new growth in each county was made equally to each of the grids in which point source growth was expected.

4. INTERNAL FUEL COMBUSTION STATIONARY SOURCES

There were no projected emissions in this source category.

5. SOLID WASTE DISPOSAL AND INCINERATION

Projected emissions from open burning were apportioned in accordance with the population factors discussed in Section VI-1.

Projected incinerator emissions in each grid square were made up of two parts: (1) that from presently operating incinerators in each grid, plus (2) the increase in incinerator emissions in each grid due to commercial/institutional growth in that grid. The latter emissions, apportioned in accordance with commercial/institutional growth, were added to 1973 baseline year emissions for each grid.

6. OFF-ROAD VEHICLES

Farm tractor emissions were apportioned to grid squares in accordance with projected agricultural factors. The decrease in county-wide agricultural activity was assumed to result from two causes: (1) encroachment of urban and suburban development upon 1973 agricultural land resulting in total elimination of emissions for this source category from these areas; and (2) a general

TABLE 58

AREA SOURCE INDUSTRIAL FUEL USE PROJECTIONS
BY IN-PLACE GROWTH AND NEW GROWTH
(Tons/Year)

MECKLENBURG COUNTY

	1973	1975	1980	1985
In-place growth	318.1	321.2	342.0	406.2
New growth	0.0	0.4	1.2	2.9
Total	318.1	321.6	343.2	409.1

FORSYTH COUNTY

	1973	1975	1980	1985
In-place growth	56.6	57.1	57.6	58.6
New growth	0.0	0.0	0.0	0.4
Total	56.6	57.1	57.6	59.0

GUILFORD COUNTY

	1973	1975	1980	1985
In-place growth	77.6	67.7	74.6	75.7
New growth	0.0	12.3	11.5	16.5
Total	77.6	80.0	86.1	92.2

decrease in activity in all other areas due to exurban development and the area's historical trend away from tilled farmland to pastureland.

Based on local planning maps the first assumption eliminated emissions from the following grids by the year indicated.

Mecklenburg County		Forsyth County		Guilford County	
277	1975	2	1985	5	1985
278	1980	3	1985	8	1985
279	1975	4	1985	20	1985
284	1980	5	1985	21	1980
285	1980	11	1985	22	1980
294	1980	12	1985	23	1985
296	1980	13	1980	77	1980
299	1980	14	1975	78	1975
300	1980	15	1985	152	1975
301	1980	16	1985	153	1975
370	1985	17	1975	154	1980
371	1985	18	1975	155	1980
383	1985	19	1985	156	1980
384	1985	20	1985	167	1980
385	1985	26	1980	168	1980
386	1985	27	1980	223	1975
387	1985	73	1975	224	1975
		74	1980	225	1980
		75	1975	226	1980
		76	1980	227	1980
		77	1980	228	1980
		158	1980	260	1975
		159	1975	262	1980
		160	1980	264	1980
		161	1975	265	1985
		162	1975		
		163	1975		
		104	1975		
		166	1980		
		167	1980		

Emissions from the remaining grid squares were then apportioned by the method used in apportioning the baseline year emissions.

Emissions from small gasoline engines were apportioned in accordance with the population factors discussed in Section VI-1.

Emissions from diesel construction equipment were apportioned in accordance with the growth in population in each grid, i.e., the difference in population between the baseline year and the projection year. This method reflects general construction, residential, commercial/institutional and highway activities which might be expected in each grid.

Emissions from both road haul locomotives and switch yard operations were apportioned to grid squares in the same way that baseline year emissions were apportioned, i.e., in accordance with train-miles travelled in each grid and the location of switch yards. Since no new railroads or switch yards are anticipated, this is equivalent to increasing emissions from each grid for both categories by the following factors:

1973 - 1975:	1.07
1973 - 1980:	1.27
1973 - 1985:	1.51

7. ROAD VEHICLES

Apportionment of road vehicle emissions should be based upon anticipated growth in traffic in the 1973 highway and urban street network and upon additional traffic in certain grids resulting from new and improved interstate and primary system. The Department of Transportation and Highway Safety, Highway Improvement Program 1976 - 1981 lists planned highway projects for these roads. These data are summarized in Table 59. With the exception of the Charlotte outer loop, all these projects are improvements of existing roads, minor realignments of existing roads, or new roads in rural areas, e.g., the Davidson bypass, which occur in only one grid. In the case of the Charlotte outer loop, procurement of right of way is not scheduled to commence until 1981. It is doubtful if the completion of any of these projects will result in significant changes in traffic routing.

Apportionment of projected road vehicle emissions was made, not by apportioning the county total emissions to grid squares, but by projecting emissions for each grid square in the following two ways:

TABLE 59

HIGHWAY IMPROVEMENT PROGRAM

County	Route No.	Location	Length (Mi)	Date	Type of Work	Amount ($1,000)
Guilford	I-85	US 311 to Groomtown	7.8	1980	Grading & structures	9,000
Guilford	NC 68	SR 1839-SR 2011	4.9	1975	Construct	11,500
Mecklenburg	NC 24-27	SR 2873-SR 3128	1.0	1975	Construct	1,000
Mecklenburg	NC 51	US 521-NC 27	19.2	1976-1978	Construct	12,200
Mecklenburg	NC 160	Charlotte Airport	20	1975	Construct	2,000
Guilford	US 220	I-85 Crossing	9.9	1977-1979	Construct	15,400
Mecklenburg	NC 16	Charlotte-NC 73	9.0	1979	Construct	10,000
Forsyth	US 311	Winston-Salem to High Point	13.3	1978-1979	Construct/ 1980 construct	19,500/6600
Mecklenburg	NC 24-27	SR 3128-NC 51	6.3	1981+	Construct	N/A
Mecklenburg	NC 73	Davidson bypass	2.8	1981	Construct	700
Mecklenburg	US 521	Pineville-SR 1133	1.5	1981+	Construct	N/A
Mecklenburg	Outer Loop	US 74-I 77	14.2	1981+	Construct	N/A

(1) For that portion of the emissions which was originally apportioned to grids by population for the baseline year (see Chapter IV, Section 7), projected emissions for each grid square were calculated using the population factors discussed in Section VI-1. This method accounted for the following proportion of county-wide emissions.

	1975	1980	1985
Mecklenburg County	59%	44%	45%
Forsyth County	49%	44%	39%
Guilford County	52%	45%	41%

(2) The remaining county-wide emissions were then apportioned to grids in proportion to the baseline year distribution of link specific emissions, that is, those emissions originally apportioned by location.

This method resulted in much larger growth in VMT on freeways and arterial highways: 8%/year in Mecklenburg, 11% in Forsyth and 9% in Guilford County, as compared to approximately 2% for other roads in each county.

8. AIRCRAFT AND AIRPORT OPERATIONS

There were nine airports that had significant projected emissions. These were assigned as follows:

Douglas Airport	- grid 304
Willgrove Airport	- grid 370
Bradford Airport	- grid 271
Smith-Reynolds Airport	- grids 37 and 38
Greensboro-High Point Airport	- grid 83
Airharbor Airport	- grid 22
May Airport	- grid 224
Causey Airport	- grid 265
Mid Atlantic Airport	- grid 156

9. VESSELS

There were no projected emissions in this source category.

10. STRUCTURAL FIRES

Apportionment of emissions from structural fires was made in accordance with the population factor discussed in Section VI-1.

11. AGRICULTURAL BURNING

There were no projected emissions in this source category.

12. UNPAVED ROAD OPERATIONS

Emissions from this source category were projected to decrease over time as rural and suburban roads are paved. The Department of Transportation and Highway Safety does not include plans for paving in the Highway Improvement Program document (discussed in Section VI-7), and could not estimate which roads would be paved and when. Consequently, since no hard data were available, emissions were allocated to grid squares in proportion to the allocation of the baseline year emissions. This is equivalent to multiplying the baseline year emissions in each grid by the following factors:

	1975	1980	1985
Mecklenburg County	0.96	0.86	0.77
Forsyth County	0.90	0.69	0.53
Guilford County	0.91	0.72	0.58

13. UNPAVED AIRSTRIP OPERATIONS

Projected emissions from this source category were assigned to grid number 370, the location of Willgrove Airport.

14. TILLING OPERATIONS

Projected emissions from this source category were apportioned in accordance with the procedures for apportionment of the farm tractor source category discussed in Section VI-6.

15. CONSTRUCTION OPERATIONS

Projected emissions from this source category were projected in the same way as the diesel construction equipment source category, Section VI-6.

16. FOREST MANAGEMENT BURNING

There were no projected emissions in this source category.

17. PAVED ROADS

Apportionment of projected emissions from this source category was in accordance with the distribution of emissions from the road vehicle category, Section VI-7.

18. WILD FOREST FIRES

There were no projected emissions in this source category.

19. AREA SOURCE PROCESS LOSSES

Projected emissions from this source category were apportioned in the same way as the area source industrial fuel usage category, Section VI-3.

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